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TRANSACTIONS

OF THE

KANSAS ACADEMY OF SCIENCE

VOLUME XXVIII

Forty-eighth Annual Meeting, Topeka,
January 14 and 15, 1916

Forty-ninth Annual Meeting, Topeka,
January 12 and 13, 1917

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CONSTITUTION OF THE ACADEMY.

SECTION I. This association shall be called the Kansas Academy of Science.

SEC. 2. The objects of this Academy shall be to increase and diffuse knowledge in the various departments of Science.

SEC. 3. The members of this Academy shall consist of two classes, active and honorary (including associate). *Active members* may be annual or life members. Annual members may be elected at any meeting of the Academy, and shall sign the constitution and pay a fee of one dollar and annual dues of one dollar; but the secretary and treasurer shall be exempt from the payment of dues during the years of their service. Any person who shall at one time contribute twenty dollars to the funds of this Academy may be elected a *life member* of the Academy, free of assessment. Any member who has paid dues to the Academy for ten consecutive years, or who has been legally exempt during any portion of that time, may be elected a *life member* on the payment of ten dollars. Any member who has been a member of this Academy in good standing for twenty years may be elected a *life member* without payment of further fees or dues. *Honorary members* may be elected on account of special prominence in science, on the written recommendation of two members of the Academy. In any case, a two-thirds vote of members present shall elect to membership. Applications for membership in any of the foregoing classes shall be referred to a committee on applications for membership, who shall consider such application and report to the Academy before election.

SEC. 4. The officers of this Academy shall be chosen by ballot at the annual meeting, and shall consist of a president, two vice presidents, a secretary, and a treasurer, who shall perform the duties usually pertaining to their respective offices. The president, the secretary, and the treasurer shall constitute the executive committee. The secretary shall have charge of all the books, collections and material property belonging to the Academy.

SEC. 5. Unless otherwise directed by the Academy, the annual meeting shall be held at such time and place as the executive committee shall designate. Other meetings may be called at the discretion of the executive committee.

SEC. 6. This constitution may be altered or amended at any annual meeting, by a vote of three-fourths of attending members of at least one year's standing. No question of amendment shall be decided on the day of its presentation.

BY-LAWS.

I. The first hour, or such part thereof as shall be necessary, in each session, shall be set aside for the transaction of the business of the Academy. The following order of business shall be observed, as far as practicable:

1. Opening.
2. Reports of officers.
3. Reports of standing committees.
4. Appointment of special committees.
5. Unfinished business.
6. New business.
7. Reports of special committees.
8. Election of officers.
9. Election of members.
10. Program.
11. Adjournment.

II. The president shall deliver a public address on the evening of one of the days of the meeting, at the expiration of his term of office.

III. No meeting of this Academy shall be held without a notice of the same having been published in the papers of the state at least thirty days previous.

IV. No bill against the Academy shall be paid by the treasurer without an order signed by the president and secretary.

V. Members who shall allow their dues to remain unpaid for two years, having been annually notified of their arrearage by the treasurer, shall have their names stricken from the roll.

VI. The secretary shall have charge of the distribution, sale and exchange of the published Transactions of the Academy, under such restrictions as may be imposed by the executive committee.

VII. Eight members shall constitute a quorum for the transaction of business.

VIII. The time allotted to the presentation of a single paper shall not exceed fifteen minutes.

IX. No paper shall be entitled to a place on the program unless the manuscript, or an abstract of the same, shall have been previously delivered to the secretary.

PAST PRESIDENTS.

1869, 1870... B. F. Mudge.
1871–1873... John Fraser.
1874–1878... F. H. Snow.
1879, 1880... B. F. Mudge.
1881, 1882... J. T. Lovewell.
1883..... A. H. Thompson.
1884, 1885... R. J. Brown.
1886..... E. L. Nichols.
1887..... J. D. Parker.
1888..... J. R. Mead.
1889..... T. H. Dinsmore, jr.
1890..... G. H. Failyer.
1891..... Robert Hay.
1892..... E. A. Popenoe.
1893..... E. H. S. Bailey.
1894..... L. E. Sayre.
1895..... Warren Knaus.
1896..... D. S. Kelley.
1897..... S. W. Williston.
1898..... D. E. Lantz.
1899..... E. B. Knerr.
1900..... A. S. Hitchcock.
1901..... E. Miller.
1902..... J. T. Willard.
1903..... J. C. Cooper.
1904..... Edward Bartow.
1905..... L. C. Wooster.
1906..... F. O. Marvin.
1907..... J. A. Yates.
1908..... E. Haworth.
1909, 1910... F. B. Dains.
1911..... J. M. McWharf.
1912..... F. W. Bushong.
1913..... A. J. Smith.
1914..... W. A. Harshbarger.
1915..... J. A. G. Shirk.
1916..... J. E. Todd.

OFFICERS OF THE ACADEMY, 1916.

President, J. E. Todd ..... Lawrence.
Vice President, Frank U. G. Agrelius..... Emporia.
Vice President, L. D. Havenhill..... Lawrence.
Treasurer, Wm. A. Harshbarger..... Topeka.
Secretary Emeritus, J. T. Lovewell..... Topeka.
Secretary, W. W. Swingle ..... Topeka.

EXECUTIVE COUNCIL.

Ex officio, the President, the Secretary, the Treasurer.

Elective for 1916.

J. A. Yates.
A. J. Smith.
J. M. McWharf.
J. A. G. Shirk.

OFFICERS OF THE ACADEMY, 1917.

President, FRANK U. G. AGRELIUS..... Emporia.
Vice President, BENNETT M. ALLEN..... Lawrence.
Vice President, L. D. HAVENHILL..... Lawrence.
Treasurer, WM. A. HARSHBARGER..... Topeka.
Secretary Emeritus, J. T. LOVEWELL..... Topeka.
Secretary, W. W. SWINGLE (to February 24, 1917)..... Topeka.
Secretary, H. WILSON SWINGLE (to December 31, 1917)... Topeka.
Secretary, GUY WEST WILSON (from January 1, 1918).... Lawrence.

EXECUTIVE COUNCIL.

Ex officio, the PRESIDENT, the SECRETARY, the TREASURER.

Elective for 1917.

LEROY HUGHBANKS, *Chairman.* J. A. G. SHIRK.
A. J. SMITH. J. M. MCWHARF.

MEMBERSHIP OF THE ACADEMY.

January 1, 1917.

Dates signify date of election to membership in the Academy.

HONORARY MEMBERS.

G. P. Grimsley, Ph. D., 1896, Thirty-first and Calvert streets, Baltimore, Md.
Edw. L. Nichols, Ph. D., 1897, Cornell Univ., Ithaca, N. Y.
W. S. Franklin, Sc. D., 1897, Lehigh Univ., South Bethlehem, Pa.
Geo. Wagner, Ph. C., 1904, Univ. of Wisconsin, Madison, Wis.
S. W. Williston, M. D., Ph. D., 1902, Univ. of Chicago, Chicago, Ill.

ASSOCIATE MEMBER.

*Mrs. R. J. Brown, 1903, Leavenworth.

LIFE MEMBERS.

E. H. S. Bailey, Ph. D., 1883, professor of chemistry, Univ. of Kansas, Lawrence.
Edward Bartow, Ph. D., 1897, director of water survey, Urbana, Ill.
Joshua William Beede, Ph. D., 1894, 404 W. Thirty-eighth street, Austin, Tex.
F. W. Bushong, Sc. D., 1896, Mellon Institute, Univ. of Pittsburg, Pa.
F. W. Cragin, Ph. D., 1880, Colorado Springs, Colo.
Geo. H. Failyer, M. Sc., 1879, Manhattan.
E. C. Franklin, Ph. D., Leland Stanford Jr. Univ., Stanford Univ., Cal.
I. D. Graham, 1879, Topeka.
Wm. Asbury Harshbarger, B. S., 1903, professor of mathematics, Washburn Coll., Topeka.
Erasmus Haworth, Ph. D., 1882, professor of geology, Univ. of Kansas, Lawrence.
W. H. Keller, A. B., 1898, instructor in mathematics, State Normal School, Emporia.
Warren Knaus, M. S., 1884, editor and publisher, McPherson.
D. E. Lantz, M. S., 1883, Biological Survey, U. S. Department of Agriculture, Washington, D. C.
J. T. Lovewell, Ph. D., 1878, Topeka.
J. M. McWharf, M. D., 1902, physician, Ottawa.
Grace R. Meeker, 1899, city librarian, Ottawa.
Ephraim Miller, Ph. D., 1873, Pasadena, Cal.
Albert B. Reagan, 1904, Culbertson, Ohio.
L. E. Sayre, Ph. M., 1885, dean of the school of pharmacy, Univ. of Kansas, Lawrence.
Alva J. Smith, 1893, city engineer, Emporia.

* Deceased.

Mrs. L. C. R. Smyth, Ph. D., 1902, Topeka.
E. G. Smyth, 1901, entomologist, Santa Rita, P. R.
Charles H. Sternberg, 1896, explorer and collector, 1315 Connecticut street, Lawrence.
M. L. Ward, D. D., 1880, professor emeritus of mathematics, Ottawa Univ., Ottawa.
J. T. Willard, Sc. D., 1883, professor of chemistry and acting president, Kansas State Agricultural Col., Manhattan.
L. C. Wooster, Ph. D., 1899, professor of zoölogy and geology, State Normal School, Emporia.
J. A. Yates, M. S., 1898, professor of geology, Manual Training Normal School, Pittsburg.

ANNUAL MEMBERS.

J. E. Ackert, Ph. D., 1917, associate professor of zoölogy, Kansas State Agr. Coll., Manhattan.
Frank U. G. Agrelius, A. M., 1905, professor of botany and bacteriology, State Normal School, Emporia.
Bennett M. Allen, Ph. D., 1913, Professor of zoölogy, Univ. of Kansas, Lawrence.
H. C. Allen, A. M., 1904, professor of chemistry, Univ. of Kansas. Lawrence.
John J. Arthur, 1904, Santa Fe shops, Topeka.
Wm. R. Arthur, B. A., 1903, Dean of the Law School, Univ. of Colorado, Boulder, Colo.
Elam Bartholomew, M. S., 1896, mycologist, Stockton.
W. E. Barker, M. D., 1916, physician, Chanute.
W. J. Baumgartner, A. M., 1904, professor of zoölogy, Univ. of Kansas, Lawrence.
W. W. Bass, M. S., 1917, instructor in physics, State Manual Training Normal School, Pittsburg.
Frank G. Bedell, 1904, Dodge City.
F. H. Billings, Ph. D., 1909, professor of botany, Univ. of Kansas, Lawrence.
Homer Blimcoe, M. S., 1917, teacher, Chapman.
H. H. Braucher, B. S., 1907, professor of manual training, State Normal School, Emporia.
Alice L. Brown, A. B., 1917, assistant instructor in zoölogy, Univ. of Kansas, Lawrence.
E. W. Brown, B. S., 1909, teacher, Chehalis, Wash.
F. W. Bruckmiller, A. B., 1914, chemist, State Water Survey, Univ. of Kansas, Lawrence.
Ernest F. Burian, Ph. B., E. E., 1916, assistant professor of physics, State Manual Training Normal School, Pittsburg.
L. D. Bushnell, B. S., 1909, professor of bacteriology, Kansas State Agr. Coll., Manhattan.
F. W. Bushong, B. S., 1896, Gulf Refining Company, Port Arthur, Tex.
Robert D. Bussey, 1917, Station D, Topeka.
H. P. Cady, Ph. D., 1904, professor of chemistry, Univ. of Kansas, Lawrence.

M. E. Canty, 1903, Fredonia.
I. D. Cardiff, Ph. D., 1909, professor of botany, Washington State Coll., Pullman, Wash.
V. B. Caris, M. A., 1911, professor of mathematics, State Manual Training Normal School, Pittsburg.
W. R. Cleveland, 1914, superintendent of schools, Mulberry.
L. C. Congdon, M. S., 1914, chief food inspector, State Board of Health, Topeka.
Connelley, Wm. E., Sec. State Historical Society, Topeka.
W. A. Cook, M. S., 1907, teacher, Osage City.
R. A. Cooley, 1910, Agricultural Experiment Station, Bozeman, Mont.
Rev. John T. Copley, 1914, Topeka.
Margaret Coventry, A. B., 1914, instructor in chemistry, State Manual Training Normal School, Pittsburg.
F. F. Crevecœur, 1900, entomologist, Onaga.
W. M. Crottinger, 1916, A. B., teacher, Burton.
S. E. Crumb, 1913, entomologist, Clarksville, Tenn.
S. J. Crumbine, M. D., 1909, secretary, State Board of Health, Topeka.
A. J. Culler, Ph. D., 1917, professor of philosophy, McPherson Coll., McPherson.
Lewis A. Curry, M. A., 1917, University of Kansas, Lawrence.
Frank B. Dains, Ph. D., 1902, professor of chemistry, Univ. of Kansas, Lawrence.
F. L. DeBeukelaer, M. A., 1916, professor of chemistry, Washburn Coll., Topeka.
George A. Dean, M. S., 1903, professor of entomology, Kansas State Agri. Coll., Manhattan.
O. P. Dellinger, Ph. D., 1909, professor of biology, State Manual Training Normal School, Pittsburg.
S. A. Deel, Ph. B., 1913, professor of physics, Baker Univ., Baldwin.
Emil O. Deer, A. M., 1905, professor of biology, Bethany Coll., Lindsborg.
R. E. Devore, A. B., 1916, teacher, Muscotah.
F. C. Dockeray, A. M., 1916, professor of psychology, Univ. of Kansas, Lawrence.
*Herman Douthitt, Ph. D., 1914, assistant professor of zoölogy and paleontology, Univ. of Kansas, Lawrence.
R. B. Dunlevy, M. A., 1896, professor of chemistry, Southwestern Kansas Coll., Winfield.
J. W. Eby, 1903, Banker, Howard.
C. W. Edmondson, Ph. D., 1909, professor of zoölogy, Univ. of Oregon, Eugene, Ore.
O. B. Edison, LL. D., 1917, attorney, 522 New England building, Topeka.
H. W. Emerson, B. S., 1904, Lawrence.
T. L. Eyerly, 1906, teacher of physiography, high school, Dallas, Tex.
Fred Faragher, A. B., 1904, Cambridge, Mass.
S. B. Flora, 1917, observer U. S. Weather Bureau, Topeka.
A. O. Garrett, 1901, teacher high school, Salt Lake City, Utah.
H. C. Givens, M. E., 1916, director of industrial training, State Manual Training Normal School, Pittsburg.

* Deceased.

A. A. Graham, 1910, attorney, Topeka.
O. S. Groner, Sc. M., 1907, professor of chemistry, Ottawa Univ., Ottawa.
Clifford J. Hall, 1917, Emporia.
Mary Harman, Ph. D., 1912, assistant professor of zoölogy, Kansas State Agri. Coll., Manhattan.
H. J. Harnly, Ph. D., 1893, McPherson College, McPherson.
J. Newton Harrison, 1915, farmer, Topeka.
L. D. Havenhill, Ph. C., Ph. M., 1904, professor of pharmacy, Univ. of Kansas, Lawrence.
Thomas J. Headlee, Ph. D., 1907, entomologist, New Jersey Agricultural Experiment Station, New Brunswick, N. J.
H. A. Horton, 1913, entomologist, McPherson.
Leroy Hughbanks, 1914, minister and lecturer, Anthony.
I. W. Humphrey, M. S., 1912, Mellon Institute, Univ. of Pittsburg, Pittsburg, Pa.
Thomas M. Iden, 1897, Ann Arbor, Mich.
Ed C. Jerman, 1911, collector, Topeka.
T. B. Jennings, 1917, director, U. S. Weather Bureau, Topeka.
A. W. Jones, B. S., 1894, Salina.
H. H. King, A. M., 1909, assistant professor of chemistry, Kansas State Agr. Coll., Manhattan.
Harry L. Kent, 1904, professor of education, Kansas State Agr. Coll., Manhattan.
John H. Klopfer, 1904, collector, Topeka.
Mary Helen Shirer Lee, A. B., 1917, 1801 MacVicar avenue, Topeka.
Thomas Armory Lee, A. M., LL. B., 1917, attorney, Topeka.
W. S. Long, A. M., 1913, assistant professor of chemistry, Univ. of Kansas, Lawrence.
Marcus A. Low, 1906, attorney C. R. I. & P. railway, Topeka.
L. A. Lowther, A. M., 1907, superintendent of schools, Emporia.
J. W. McCulloch, B. S., 1911, instructor in entomology, Kansas State Agr. Coll., Manhattan.
David F. McFarland, Ph. D., 1903, Univ. of Illinois, Urbana, Ill.
R. Matthews, D. D. S., 1898, dentist, Wichita.
B. W. Merwin, 1914, archæologist, Savonburg.
C. F. Menninger, M. D., 1903, physician, Topeka.
S. T. Millard, M. D., 1909, physician and surgeon, Topeka.
U. G. Mitchell, Ph. D., 1914, assistant professor of mathematics, Univ. of Kansas, Lawrence.
Robert E. Mohler, A. B., 1914, professor of agriculture, McPherson Coll., McPherson.
Roy L. Moodie, Ph. D., 1908, Univ. of Illinois, Coll. of Medicine, Chicago, Ill.
Merle M. Moore, 1909, El Segundo, Cal.
Agnes Anderson Murray, A. M., 1913, chemical laboratory, Univ. of Kansas, Lawrence.
R. K. Nabours, Ph. D., 1910, professor of zoölogy, Kansas State Agri. Coll. Manhattan.

C. A. Nash, 1907, Univ. of Cincinnati, Cincinnati, Ohio.
C. F. Nelson, Ph. D., 1914, associate professor of physiological chemistry, Univ. Kansas, Lawrence.
N. P. Neilson, 1906, architect, Topeka.
A. M. Nissen, 1888, Wetmore.
Nadine Nowlin, M. A., 1917, instructor in zoölogy, Univ. of Kansas, Lawrence.
H. H. Oldenkirk, A. B., 1916, principal high school, Pittsburg.
Harry N. Olson, 1905, Bethany Coll., Lindsborg.
Earle O'Roke, M. A., 1917, department of zoölogy, Univ. of Wyoming, Laramie, Wyo.
F. T. Owen, Ph. D., 1917, professor of chemistry, Coll. of Emporia, Emporia.
S. L. Palmer, 1917, collector, route 3, Hutchinson.
J. B. Parker, 1908, assistant in entomology, Kansas State Agri. Coll., Manhattan.
*Horace W. Parson, D. D. S., 1916, dentist, Wamego.
Frank Patrick, 1903, microscopist, Kansas City, Mo.
Leslie F. Paull, B. S., 1903, State Coll. of Agriculture, Fort Collins, Colo.
L. M. Peace, A. M., 1904, botanical laboratory, Univ. of Kansas, Lawrence.
Edison Pettit, B. E., 1914, director of Washburn observatory, Washburn Coll., Topeka.
L. M. Plairs, 1910, assistant entomologist, Kansas State Agri. Coll., Manhattan.
L. M. Powell, M. D., 1906, physician, Topeka.
Silas Eber Price, D. D., 1909, president Ottawa Univ., Ottawa.
Wm. S. Prout, M. D., 1904, physician, Emmett.
D. L. Randall, Ph. D., 1910, professor of chemistry, Baker Univ., Baldwin.
S. L. Redman, 1914, professor of physics, State Manual Training Normal School, Pittsburg.
Geo. S. Rex, 1911, manager of testing plant, A. T. & S. F. railway, Topeka.
H. A. Rice, C. E., 1909, professor of mechanics and structural engineering, Univ. of Kansas, Lawrence.
E. F. A. Reinisch, 1917, superintendent of parks, Topeka.
*J. Risser, Ph. D., 1913, professor of zoölogy, Washburn Coll., Topeka.
W. R. B. Robertson, Ph. D., 1905, assistant professor of zoölogy, Univ. of Kansas, Lawrence.
J. Rogers, M. A., 1917, Univ. of Kansas, Lawrence.
Eulalia E. Roseberry, B. S., 1909, professor of geography, State Manual Training Normal School, Pittsburg.
H. C. Rule, A. M., 1917, teacher, Arcadia.
J. C. Russell, 1911, professor of chemistry, McPherson Coll., McPherson.
Frank K. Sanders, D. D., Ph. D., LL. D., 1909, New York city.
D. C. Schaffner, A. M., 1903, professor of zoölogy, Coll. of Emporia, Emporia.

---

* Deceased.

John H. Schaffner, A. M., M. S., 1902, professor of botany, State Univ. of Ohio, Columbus, Ohio.

Thomas S. Scheffer, M. S., 1903, Bureau of Biological Survey, U. S. Department of Agriculture, Washinton, D. C.

B. W. Scheib, M. A., 1914, professor of agriculture, State Manual Training Normal School, Pittsburg.

M. M. Schmidt, 1914, Home City.

Sister M. Sebastian, 1911, professor of zoölogy, St. Mary's of the Plains Coll., Dodge City.

Edwin Taylor Shelly, M. D., 1892, physician, Atchison.

Noble P. Sherwood, Ph. D., 1916, professor of bacteriology, Univ. of Kansas, Lawrence.

Claude J. Shirk, A. M., M. S., 1905, professor of botany, Nebraska Wesleyan Univ., University Place, Neb.

J. A. G. Shirk, M. S., 1904, professor of mathematics, State Manual Training Normal School, Pittsburg.

Ralph C. Shuey, 1905, chemist with Armour Packing Co., 13062 Fifty-fourth street, Chicago, Ill.

Charles A. Shull, Ph. D., 1917, professor of botany, Univ. of Kansas, Lawrence.

E. Claude Smith, D. O. S., 1917, Osteopath, Topeka.

Arthur B. Sperry, B. S., 1917, zoölogical laboratory, Univ. of Kansas, Lawrence.

S. G. Stewart, M. D., 1904, physician and surgeon, Topeka.

Charles M. Sterling, A. B., 1904, assistant professor of pharmocognosy, Univ. of Kansas, Lawrence.

Frank P. Strickland, jr., 1917, chemist, 2072 W. Fifth street, Kansas City, Kan.

Frank Strong, Ph. D., LL. D., 1905, chancellor, Univ. of Kansas, Lawrence.

E. F. Stimpson, B. S., 1904, assistant professor of physics, Univ. of Kansas, Lawrence.

H. Wilson Swingle, 1917, Lawrence.

Wilbur W. Swingle, A. M., 1916, instructor in zoölogy, Univ. of Kansas, Lawrence.

M. C. Tanquary, Ph. D., 1912, assistant professor of entomology, Kansas State Agr. Coll., Manhattan.

E. L. Teague, A. M., 1912, assistant professor of chemistry, Kansas State Agri. Coll., Manhattan.

Arthur C. Terrill, A. M., E. M., 1917, professor of mining and ore dressing, Univ. of Kansas, Lawrence.

George Terry, M. A., 1917, Lawrence.

George W. Tidd, M. S., 1914, professor of physics, State Normal School, Emporia.

J. E. Todd, A. M., 1907, professor of geology, Univ. of Kansas, Lawrence.

David Train, 1907, Bethany Coll., Lindsborg.

E. S. Tucker, A. M., 1904, associate professor of entomology, Louisiana State Univ., Roseland Terrace, Baton Rouge, La.

W. H. Twenhofel, Ph. D., 1910, professor of geology, Univ. of Wisconsin, Madison, Wis.

Edith M. Twiss, Ph. D., 1910, professor of botany, Washburn Coll., Topeka.

William Van Orsdal, A. B., 1916, principal of high school, Oakland.

Henry L. Viereck, 1913, entomologist, Sacramento, Cal.

P. F. Walker, M. M. E., 1905, dean of the school of engineering, Univ. of Kansas, Lawrence.

J. D. Walters, M. S., D. A., 1894, professor of architectural drawing, Kansas State Agricultural Coll., Manhattan.

Lawrence A. Wallworth, 1913, taxidermist, Vallejo, Cal.

E. C. Warfel, A. M., 1909, attorney, Topeka.

H. J. Waters, LL. D., 1909, president of Kansas State Agr. Coll., Manhattan.

George N. Watson, Ph. C., 1916, assistant professor of pharmacy, Univ. of Kansas, Lawrence.

E. R. Weidlein, M. A., 1911, Mellon Institute, Pittsburg, Pa.

J. E. Welin, A. M., M. S., 1899, professor of chemistry, Bethany Coll., Lindsborg.

Ella Weeks, 1903, Kansas State Agr. Coll., Manhattan.

E. N. Wentworth, Ph. D., 1917, professor of animal husbandry, Kansas State Agr. Coll., Manhattan.

J. B. Whelan, A. M., 1909, Lawrence.

E. A. White, A. B., 1909, Lawrence.

Clement C. Williams, B. S., C. E., 1917, professor of railway engineering, Univ. of Kansas, Lawrence.

Guy West Wilson, A. M., M. S., 1917, secretary Kansas Academy of Science, Lawrence.

Stanley D. Wilson, B. A., 1910, instructor in chemistry, Univ. of Chicago, Chicago, Ill.

W. B. Wilson, M. S., 1903, professor of biology, Ottawa Univ., Ottawa.

C. H. Withington, A. M., 1903, Topeka.

T. M. Wood, B. S., 1909, professor of mathematics, Fort Hays Kansas Normal School, Hays.

H. I. Woods, M. S., 1902, professor of physics and astronomy, Washburn Coll., Topeka.

Clifford C. Young, A. B., 1909, director State Water Survey, Univ. of of Kansas, Lawrence.

Societies Affiliated with the Kansas Academy of Science.

The Society of Biological Research, Univ. of Kansas, Lawrence. W. W. Swingle, President. Membership, 21.

The Kaw Valley Radio Association, Topeka. Kenneth Sutherland, president, 1411 Harrison street. Membership, 26.

MINUTES OF THE FORTY-EIGHTH ANNUAL MEETING, KANSAS ACADEMY OF SCIENCE.

TOPEKA, January 14, 1916.

The forty-eighth annual meeting of the Kansas Academy of Science convened in the assembly room of Memorial Hall, Topeka, and was called to order by the president, J. A. G. Shirk.

The secretary's report of the forty-seventh annual meeting, at Topeka, was accepted as printed in the twenty-seventh volume of the Transactions.

The secretary reported the removal of the offices of the Academy to new quarters in Memorial Hall, with the expectation that the library would be shelved and catalogued by the Historical Society. So far nothing has been accomplished in this line. The museum was boxed and moved also, the work being let to the lowest bidder without regard to his competency. The resultant damage to the collections was so serious that it is doubtful if they can ever be put into usable condition again. These collections contained contributions from Snow, Mudge, Parker, Savage, and many others. The collection of Kansas minerals which was prepared for the Louisiana Purchase Exposition was secured to the Academy through the efforts of Professor Grimsley. Altogether these collections were rightly considered an excellent foundation for an economic museum, and their loss would be most deplorable.

Professor Bailey moved that a committee of nine be appointed to consider the general condition and welfare of the Academy. Twelve names were presented, the ballot resulting in the election of the following: Sayre, Bailey, Yates, Willard, Todd, Mrs. Smyth, McWharf, H. C. Allen, and Harshbarger.

The following committees were appointed by the president:

Nominations: Willard, Yates, Sayre.
Resolutions: Allen, Agrelius, Mrs. Smyth.
Program: Agrelius, Nelson, Mrs. Smyth.
Necrology: Willard, Wooster, Lovewell.
Audit: Nelson, Agrelius.
Membership: Yates, Agrelius.
Publication: Bailey, Willard, Agrelius.
Press: Dr. McWharf, Sayre, Lovewell.
Legislation: Allen, Knaus, Wooster, Sayre, Yates.

The treasurer submitted the following report:

TREASURER'S REPORT

to the Kansas Academy of Science for the year ending January 14, 1916.

Balance brought over from 1914	$999.44
Collected as dues and memberships	48.00
Received from sale of Transactions	6.98
Received as interest on deposits	30.79
Total receipts	$1,085.21
Disbursements:	
Lecturer, stenographer, executive committee, etc	$140.80
Additions to library	13.09
Total disbursements	$153.89
Academy funds on hand January 14, 1916:	
In the hands of the secretary	$4.40
In the hands of the treasurer	926.92
Total	$931.32

L. D. HAVENHILL, *Treasurer.*

Report referred to the Auditing Committee.

The address of the retiring president being next in order, President Shirk gave a most interesting address on "American Highways." This is published in Bulletin No. 2 of the Academy.

The following is the list of papers presented at this meeting:

1. World Wars. A. A. Graham.
2. Lasting and Universal Peace. A. A. Graham.
3. The Degeneracy of Monarchs. A. A. Graham.
4. Italian Degeneracy. A. A. Graham.
5. Civilized Europe; a Chapter in Anthropology. A. A. Graham.
6. The Insanity of Nations; the Cause of the Present World War a Physiological Question. A. A. Graham.
7. Botanical Notes. Frank U. G. Agrelius.
8. Some Experiments with *Bacillus coli-communis* (Escherich). Frank U. G. Agrelius.
9. Observations on the Cause of Decay in Various Materials. Frank U. G. Agrelius.
10. Observations on Jupiter at Opposition in 1915. Edison Pettit.
11. Note on a Device for Setting a Heliostat in the Meridian. Edison Pettit.
12. Celestial Photography with the Washburn Telescope. Edison Pettit.
13. Additions to the List of Kansas Coleoptera, 1913 to 1916. W. Knaus.
14. Some Life History Notes on *Phytomonus eximius.* W. Knaus.
15. Rare Coleoptera from the Sand Hill Region of Reno county. W. Knaus.

16. The Clan System of the Wyandotte Indians. William E. Connelley.
17. *Echinacea;* its Combination and Use. J. M. McWharf.
18. Notes on Kansas Mammals. D. E. Lantz.
19. Presidential Address—American Highways. J. A. G. Shirk.
20. Properties of Kansas Clays. Paul Tettor.
21. The Comanchean of Central Kansas. W. H. Twenhofel.
22. The Scientist on the Farm. L. C. Wooster.
23. Relative Toxicity of Aromatic Oils and Inorganic Compounds to Fungi. L. J. Reiser.
24. The Shoshoni-Gorship Indians of Utah. A. B. Reagan.
25. Lecture: Some Nutritional Characteristics of Corn. J. T. Willard.
26. The New Public Health. J. C. Crumbine.
27. A Study of Foods for Infants. Leon A. Congdon.
28. Stramonium. L. D. Havenhill.
29. Some Chemical Products of Fatigue and Their Possible Relation to Mental Efficiency. F. C. Dockeray.
30. A Method for the Quantitative Determination of Salicylic Acid in the Presence of Acetyl Salicylic Acid. G. N. Watson.
31. Isolation of the Toxic Principles of Coffee, and the determination of Their Toxicity. L. E. Sayre.
32. Calcium Metabolism. C. F. Nelson.
33. Differentiation Within the Acid Fast Group of Organisms. N. P. Sherwood.
34. Breeding Habits of Some Annelids. W. J. Baumgartner.
35. Eugenic Studies in Kansas. W. R. B. Robertson.
36. The Relation Between the Germ Cells and the Environment. Bennett M. Allen.
37. Population Changes and Industrial Development. P. F. Walker.
38. Explosions in Kansas Coal Mines: Their Cause and Prevention. A. C. Terrill.
39. History of the Kaw Lake. J. E. Todd.
40. Eolian Loess. J. E. Todd.
41. On the Occurrence of Starch in Green Fruits. E. H. S. Bailey and W. S. Long.
42. The Chemical Characteristics of Ground Water. F. W. Bruckmiller.
43. Effect of Inanition upon Gonads and Germ Cells of Frog Larvæ. W. W. Swingle.

The remainder of the sessions for the day were devoted to the reading of papers. At the evening session Dr. J. T. Willard, professor of chemistry at Kansas State Agricultural College, delivered an illustrated lecture entitled "Some nutritional characteristics of corn."

Saturday, January 15.

The Academy resumed its session in Memorial Hall for the reading of papers. After listening to a number of papers the Academy turned its attention to the transaction of business.

The Committee on Policy made its report, which was accepted by the Academy.

The Membership Committee reported the following persons as recommended for election:

Annual members: Dr. W. E. Barker, physician, Chanute; F. L. De Beukelaer, professor of chemistry, Washburn College, Topeka; Ernest F. Burian, assistant professor of physics, Manual Training Normal School, Pittsburg; Wm. E. Connelley, State Historical Society, Topeka; R. E. Devore, teacher, Muscotah; F. C. Dockery, professor of psychology, University of Kansas, Lawrence; H. C. Givens, director of industrial training, Manual Training Normal School, Pittsburg; J. Newton Harrison, farmer, Topeka; H. H. Oldenkirk, principal of the high school, Pittsburg; Horace W. Parson, D. D. S., denist, Wamego; N. P. Sherwood, professor of bacteriology, University of Kansas, Lawrence; Dr. J. W. Scott, professor of zoölogy, Kansas State Agricultural College, Manhattan; Wilbur W. Swingle, Topeka; William Van Orsdal, principal of the high school, Oakland; George N. Watson, assistant professor of pharmacy, University of Kansas, Lawrence.

Life members: W. H. Keller, professor of mathematics, State Normal School, Emporia; C. S. Proser, professor of geology, Ohio State University, Columbus, Ohio.

Upon motion of Professor Harshbarger, the rules were suspended and the secretary instructed to cast the ballot of the Academy for these nominees. The ballot was cast.

The Auditing Committee reported that they had examined the treasurer's accounts and found them correct. Report adopted.

The Committee on Necrology reported that they had learned of but two deaths. A biographical sketch of Prof. F. O. Marvin appeared in volume 27 of the Transactions, and that of Prof. L. L. Dyche is being prepared. Report accepted.

Doctor Lovewell then made the following statement to the Academy:

Mr. President and Members of the Academy: You have honored me with a continuance of election to the important office of secretary for more than ten years, and of course you are aware—I do not need to advertise—that, like other people, I am getting old. I do not hesitate to acknowledge that fact, and I hope you will be able to report at the proper time that you are as old as I am now, and will have an equal amount of physical vigor as I have at this present time. Still I am aware that the work of the secretary of the Academy would be better performed by a younger member of the Academy, and this is a time when the interests of the Academy are far more important and require consideration on the part of the members. If it should be your pleasure to honor me with a further continuance of the secretaryship, I should feel myself under

obligation to do certain things which perhaps my knowledge of the situation here will enable me to do better than an entirely new person, and, therefore, if that continuation of office should be granted to me, I should wish to present at this time my resignation of the office of secretary, to take effect at the end of the fiscal year—that is, the 1st of July—and I hereby make that request. Of course I realize that only by your election could I be considered an officer of the Academy, since your officers are elected annually; but I wish to be relieved from the burdens of this office not later than the 1st of July. I hereby turn to you this provisional resignation of the office of secretary.

Professor Wooster then made the report of the Committee on Nominations, as follows:

The committee has felt a very great weight of responsibility. It has passed the most critical point in the history of the Academy. If we were wholly dependent upon ourselves, we could be guided wholly by our own feelings, and as one of the old men of the Academy—I can hardly realize that I am, but it cannot be denied—and one who has known our secretary for over thirty years—met him, I believe, the first time he attended the Academy—I am touchingly moved by the present question. Those of us who have known Doctor Lovewell during this time have had the highest esteem for his qualifications as a teacher and student, as a worker in the Academy, and as a friend. We have held him in high position in our affection, as well as in esteem for the work he did as a teacher and in public scientific work. In the early days he organized the Kansas Weather Service. He was one of the noted scientific men of the state, and it is with the greatest regret that we realize that time has laid its burden upon him; that he is no longer able to bear the heavy work of administration, and of meeting the members of the legislature and the men within the state. We feel that there should be some recognition of the relation which he has held to the Academy for so long. While feeling, from a sense of responsibility, that it is necessary for a younger man to take up the burden of carrying constantly the Academy in its public relations, the Committee on Nominations, a fraction of the committee on the welfare of the Academy, which was appointed yesterday, has thought of little else during the last twenty-four hours. We believe that it is possible for the Academy to be a much greater power in the state than it has ever been before. We believe that it is possible for this Academy to stand for the relation of science, on all questions, to the welfare and development of the state in the same way as the State Board of Agriculture represents the great agricultural interests. To do this requires the enlistment of the scientific forces throughout the state; not merely those in the state institutions, not those in colleges supported through the efforts of the churches, but men in private life and in the high schools and professions who appreciate the importance and value of science should be united in this Academy and enabled through its organization to make scientific knowledge and its application what it should be for the interests of the entire state.

Now I did not think of making a speech so long as this, but I have

tried to give you an impression perhaps of the responsibility which we have felt in this matter. The names we have to suggest have been selected from this point of view. We feel that we have done our duty in the matter, as we see it, and leave it to the Academy to settle things as in its wisdom it may deem best. We believe that for the most part the Academy should be in the hands of the younger members, people who have the time, who have the ambition, who are up to date, who are in the world's work, or are entering upon it, and who can do this work better than the older members can. These old members, I am sure, will always be willing to assist in any way that comes into their power, but we believe that they should be relieved from the responsibility for the most part. These are the nominations of the committee:

President, J. E. Todd; vice presidents, F. G. Agrelius and L. D. Havenhill; treasurer, Wm. A. Harshbarger; secretary emeritus, J. T. Lovewell; secretary, W. W. Swingle; elective members of the executive council, J. A. Yates, A. J. Smith, J. M. McWharf, and J. A. G. Shirk.

You will note that this report recommends that the office of secretary emeritus be created for our esteemed secretary. This will give him a relation through which he can help the Academy as his heart prompts him, and also bears a recognition for the service which he has given, and the esteem in which he is held.

The rules were suspended and the secretary was instructed to cast the ballot. The ballot was cast and the nominees declared elected.

Dean Sayre then made the following motion:

Mr. Chairman: As a member of this committee, and in connection with this subject that we have raised, I would like to say a few words. I think it due the Academy that something might be said. No one realizes more than myself the necessity we have for making new connections and new friendships in our work. When we change from young to old and pass upon the stage of life, sometimes our friends leave us and we are constantly throwing out new threads of friendship. I think most of you who have been with Professor Lovewell in his work know how valuable it has been, how honestly he has labored for the organization, and with what patience for this work. As has just been said, I have been associated with him now for thirty years, and am impressed with his valuable services to the Academy. I am persuaded by these circumstances to ask that the members of the younger generation join together with the older members and give a rising vote of thanks to our secretary, who will retire in June.

The vote was given.

Motion made by Professor Yates that the matter of labeling the room occupied by the Academy be taken up by a committee composed of the president, the secretary, and Mr. Congdon. Motion carried.

Moved and seconded that Doctor Willard's paper be issued in bulletin form. Motion carried.

Moved and seconded that the president's address be published as a bulletin. Motion carried.

The Committee on Resolutions presented the following:

Resolved: That we, the members in attendance at the forty-eighth annual meeting of the Kansas Academy of Science, desire to express appreciation of the courtesy accorded our organization by the press of Topeka in the matter of advance notices and daily reports of meetings, and herewith register our sincere thanks for the same.

Resolved, That we also appreciate the kindly coöperation and willing assistance of the secretary of the Historical Society in providing many necessary conveniences and improvements in the furnishing of our quarters and in preparation for the present meeting, and extend to him and to the organization which he represents our hearty thanks for the same.

Resolved, That the Academy should determine, individually and collectively, to rally to the situation and renew its activity along the lines of scientific research; also that we urge a campaign throughout the state for increased membership, and also outline a propaganda for greater publicity for the work already done and that which is now in progress by the organization and its members.

Resolved, That the Academy realizes most deeply the splendid loyalty and devotion to the duties of the office of our secretary during a decade of service, and that we desire to express through the feeble medium of words the heart-full appreciation and thanks of this body assembled, of his personality and presence among us for such a length of years.

The report was adopted.

The Academy resumed the reading of papers, and upon the completion of the program adjourned.

MINUTES OF THE FORTY-NINTH ANNUAL MEETING, KANSAS ACADEMY OF SCIENCE.

TOPEKA, January 12, 1917.

The forty-ninth annual meeting of the Kansas Academy of Science convened in the assembly room of Memorial Hall, Topeka. The session was called to order at 10 a. m. by the president, J. E. Todd.

The minutes of the forty-eighth annual meeting were read and approved.

The secretary then read the following report, which was accepted and placed on file:

REPORT OF THE SECRETARY.

Mr. President and Members of the Kansas Academy of Science: The present secretary assumed office July 1, 1916, relieving Dr. J. T. Lovewell, secretary for the past ten years. Upon assuming the office the secretary began at once to carry out certain instructions received from the Executive Committee. These instructions for handling the office and the line of work which the Academy was to follow for the ensuing year were, I understand, decided upon at the last annual meeting of the Academy. These instructions have been faithfully followed by the secretary as far as possible. The following is a brief statement of the suggestions made to me and the results obtained in following them out.

1. It was suggested that I have Mr. Connelley, of the Historical Society, start his assistants at work cataloguing our library. This was promised by Mr. Connelley two years ago, but for various reasons he has not seen fit to begin the work. At the suggestion of Mr. Connelley, the secretary deposited with the Library of Congress, from the contingent fund of the Academy, $16 for index cards to be used in the work of cataloguing our library. I still hold the receipt, as the cards were never used.

As the matter now stands, four thousand of our books are shelved, labeled and classified, but not catalogued, and hence useless for reference purposes. Half of the work towards putting our library in shape is completed; half remains undone.

At present the secretary piles on the floor all the new books and pamphlets that are received by the Academy, as there is no other place to put them. The Historical Society has placed many of our books and periodicals with their library, in order to complete broken files. The secretary, however, has a list of these books upon their shelves.

2. Upon assuming the office of secretary I attempted to carry out a second suggestion made to me by the committee, namely, to build up an economic museum representing all the natural resources of the state, such as coal, salt, oils, lead and zinc, building stone, etc. After having

mailed out over seven hundred letters to producers within the state and writing to various museums throughout the United States asking for the loan of duplicate collections, the attempt to build up an economic museum by letter writing was abandoned.

One of our old-time members, Mr. E. F. Crevecœur, of Onaga, Kan., last summer offered the Academy, for the expense of transportation, the loan of his museum, comprising 15,000 specimens of birds, reptiles and mammals. I wrote to the Executive Committee regarding the matter, but they did not seem enthusiastic. Mr. Crevecœur now asks $200 for his museum. It is worth many times more than that, but I judge he wants this for his display cases.

At present we have no museum worthy of the name and are not likely to have unless some one is kept in the field gathering the specimens from the various industrial concerns. Our old museum is worthless since moving to our new quarters in Memorial Hall; the specimens are not labeled, are filthy, and jumbled together in every way. A short time ago the building was being cleaned and our so-called museum made such an unsightly showing that I obtained the permission of some of the members of the Academy to get rid of the specimens of minerals, etc., by sending them to the State University to be used in the ore-dressing department. They were useless for purposes of the Academy or for any purpose of display.

3. Acting on the advice of Dean Sayre and Professor Bailey, I started a course of popular scientific lectures in Topeka. The lectures were mostly given by members of the Academy and were of a popular sort, but of high educational value, and free to the public. The lectures so far given are as follows:

September 15. Origin of the Earth. W. W. Swingle.
September 27. Outline of Cosmic Evolution. Prof. Edison Petitt, Washburn College.
October 13. Evolution of Life. Dr. Bennett M. Allen, University of Kansas.
October 27. Extinct Animals of the Past. Dr. Herman Douthitt, University of Kansas.
November 8. Evolution of Sex in Plants and its Biological Significance. Dr. Charles A. Shull, University of Kansas.
December 1. Serum Therapy and Theory of Immunity. Prof. N. P. Sherwood, University of Kansas.
January 12. Microbes and Disease. Dr. John Sundwall, Kansas University.
January 19. Spiritualism and Mediumship in the Light of Modern Psychology. Dr. S. G. Heffelblower, University of Kansas.

Following this there will be lectures upon liquid air, eugenics, wireless telegraphy, parasites of man, and sex determination, and Luther Burbank. The lectures have been a success in every way. We have had so large an attendance that we have been forced to use the large G. A. R. Hall.

4. Another activity of the Academy was the oil and gas survey of the state, made by the secretary and Mr. G. R. Smith, of Lawrence. Owing to the recent oil boom in Butler county, Kansas, the office of the Academy has been flooded with letters seeking information regarding

the oil and gas situation in Kansas. As there were no statistics available less than nine years of age, the last being volume 9 of the Geological Survey, the Executive Committee decided that an oil and gas survey by the Academy would be a good thing both for the Academy and for the state. Three hundred dollars was appropriated from our private funds for the expenses of the survey and the work began, with what success the members will have to decide for themselves when the report is made, which will be later in the meeting, as it is entirely too long for presentation at this time. The expenses of the survey to date have been $160.

5. In regard to the matter of our 1915 Transactions, it may be said that the state printer would not consider printing them until spring, legislative year being a very busy one for him. They will be published this spring (1917), and the secretary suggests that the 1915 and 1916 Transactions be printed together. This will be possible if the members of the Academy will hurry their papers along somewhat.

6. In regard to the matter of appropriations for the Academy for the biennium of 1918 and 1919, the secretary, after conferring with Professors Sayre and Todd, sent in an estimate of the appropriations needed for the Academy.

Respectfully submitted.

W. W. SWINGLE, *Secretary.*

The Treasurer then presented his report, which was referred to the Auditing Committee.

REPORT OF THE TREASURER FOR THE YEAR 1916.

TOPEKA, KAN., January 12, 1917.

Received from the retiring treasurer	$934.86
Received from annual dues	55.60
Received in interest on certificates	44.13
Total receipts	$1,034.59
Expended as per check book	239.25
Balance on hand	$795.34
Resources:	
Certificates on State Savings Bank	$625.00
Balance in State Savings Bank	16.87
Balance in Merchants National Bank	153.47
Total Academy moneys	$795.34

W. A. HARSHBARGER, *Treasurer.*

The standing committees were then announced:

Nominations: Wooster, Shirk, Willard.
Resolutions: McWharf, Billings, Tague.
Program: Baumgartner, Mrs. Smyth, Congdon.
Necrology: Bailey, Woods, Tidd.
Auditing: Reisser, Smith.
Membership: Swingle, Yates, Knaus.
Publication: Allen, Harshbarger, Willard.
Press: Sayre, King, Swingle.
Legislation: Allen, Knaus, Worcester, Sayre, Yates.
Research: Walker, Willard, Yates, Agrelius.

Mr. Knaus asked to be released from the Legislative Committee and that Professor Harshbarger be appointed in his place. The change was accepted by the Academy.

In the absence of Professor Tidd, Professor Risser was appointed to the Auditing Committee.

Moved by Mr. Knaus that a committee consisting of the incoming president, the secretary, and Professor Harshbarger be appointed to confer with the ways and means committee of the legislature in regard to refunding the $300 paid by the Academy for the Oil and Gas Survey. Motion adopted.

Upon motion of Professor Bailey and Dean Sayre, a committee of three was appointed on revision of the constitution. Professor Bailey, Dean Sayre and Mr. Knaus were appointed.

Professors Tidd and Smith moved that the secretary send a report of the meeting of the Academy to Science for publication. Motion adopted.

President Todd suggested that the matter of the Executive Committee and Executive Council be referred to the Committee on Revision of the Constitution.

Motion made by Prof. Alva Smith and Mr. Swingle that a committee be appointed to confer with the governor on the future of the Academy. Motion carried.

Professor Agrelius was elected chairman of the biological section.

The Academy then proceeded to the reading of papers. Two papers were then read: Foreign Additions to Our Dietary, by Professor Bailey, and Cultivation of Medicinal Plants, by Dean Sayre. The Academy then adjourned at 12:30 p. m.

AFTERNOON SESSION.

The Academy reconvened at 1:30 p. m. to listen to the president's address, by President Todd, on "Kansas in the Ice Age."

The Academy then divided into sections for the reading of papers. Section 1 included physics and chemistry, section 2 included biological science, section 3 included papers of general interest.

The sectional programs are presented herewith:

SECTION 1.—*Physics and Chemistry:*

1. Lecture: Measurement of the Light and Heat of the Stars. Prof. E. Pettit, director of Washburn Observatory.
2. Method for the Determination of Starch. Prof. W. S. Long, State Food Laboratory.

3. Artificial Rubber, Prof. L. E. Sayre, Ph. M., Kansas University.
4. Our Mining Future. Prof. A. C. Terrill, M. E., Kansas University.
5. Notes on Stramonium. Prof. L. D. Havenhill, Ph. M., Kansas University.
6. Utilization of Solar Energy. H. W. Swingle, Topeka.
7. The Adulteration of Jams and Jellies. Prof. W. S. Long, State Food Laboratory.
8. Notes on Mescale Buttons. Prof. L. E. Sayre.
9. So-called Elements. Dr. J. T. Lovewell, Topeka.
10. Alfalfa Flour. Miss Sprague, B. S., Kansas University.
11. Notes on the Strata of Deep Wells in Butler County. G. R. Smith, Lawrence.
12. Total Solar Eclipse, June 8, 1918. Prof. E. Pettit.
13. Further Note on Corn Oil and the New Point of View in Food Values. Prof. L. E. Sayre.
14. The Relation Between the Quantities of Tin and Hydrogen in "Springers." W. S. Long.
15. Double Star Measurements at Washburn College. Prof. E. Pettit.
16. The Composition of Commercial Fruit Extracts. W. S. Long.
17. Oil and Gas Survey of Butler County, Kansas. W. W. Swingle, M. A., Topeka.
18. Shifting of Cities. A. A. Graham, LL. B., Topeka.
19. Some Common Fallacies About Kansas Weather. S. D. Flora, Weather Bureau, Topeka.
20. Analyses and Comparative Heating Values of Natural Gas and Coals. Prof. H. C. Allen, University of Kansas.

SECTION 2.—*Biological Science:*

1. Lecture: The Karakul Sheep, and Other Domesticated Animals of Central Asia. Prof. R. K. Nabours, Kansas State Agricultural College.
2. Five Years' Research in the Fossil Fields of Alberta. Dr. Charles Sternberg, Lawrence.
3. Botanical Notes, 1917. Prof. F. G. Agrelius, M. A., State Normal School, Emporia.
4. Some Recently Discovered Kansas Coleoptera. Warren Knaus, McPherson.
5. Cultivation of Medicinal Plants in the United States. Prof. L. E. Sayre, Ph. M.
6. The Domestic Cat—A Host of the Dog Tapeworm, *Tænia pisiformis* Bloch. Prof. J. E. Ackert, Kansas State Agricultural College, Manhattan.
7. Heredity and Education. Prof. L. C. Wooster, Ph. D., State Normal School, Emporia.
8. Collecting Notes on Kansas Coleoptera. Warren Knaus, McPherson.
9. Birds of the Bois Fort Indian Reservation and Adjacent Territory in Minnesota. Prof. A. B. Reagan, Ignacio, Colo.

10. Experimental Investigation of Thyroid and Pituitary Glands. Prof. B. M. Allen, Ph. D., Kansas University.
11. Extirpation of Thyroid Glands and Its Effect on Other Glands. Prof. Bennett M. Allen, Ph. D
12. Extirpation of Thyroid Glands and its Effect on Growth. Mr. George Terry, M. A., Lawrence.
13. Investigation of the Relation of Thymus and Pituitary Glands to Body Growth. W. W. Swingle, M. A., Topeka.
14. Life Cycles of Some New Species of Trematodes. Earl O'Roke, M. A., Lawrence.
15. Origin of the Sex Cords and Interstitial Cells in *Rana pipens*. W. W. Swingle, A. M.
16. The Spermatogenesis of the Domestic Chick. Lewis Curry, M. A.
17. The Singing Locust. A. A. Graham, Topeka.
18. Comparative Study of the Effects of Caffein on Athletics and Untrained Subjects. Dr. Ida Hyde, Ph. D.
19. Observations on Moles of our Northwest Country. Prof. Theo. S. Scheffer, M. S., U. S. Biological Survey.
20. Inheritance of Fertility in Sheep. Prof. E. N. Wentworth, Kansas State Agricultural College, Manhattan.
21. The Influence of the Separator upon Distribution of Bacteria in Milk and Cream. L. D. Bushnell and O. W. Hunter, Kansas State Agricultural College, Manhattan.
22. The Microbal Flora of Graded Cream. O. W. Hunter and L. D. Bushnell.
23. Experience with an Outbreak of Grasshoppers on Overflowed Lands in Louisiana. E. S. Tucker, Agricultural Experiment Station, Baton Rouge, La.
24. Determinations and Records of Insects Collected at Plano, Texas. E. S. Tucker.
25. Notes on the Green Bug in Texas. E. S. Tucker.
26. The Algæ of Kansas Reservoirs. J. B. McNaught, Lawrence.
27. The Unencysting of *Vorticella*. Nadine Nowlin, Lawrence.

SECTION 3.—*General Papers:*

1. Activated Sludge—A New Method of Sewage Disposal. C. A. Haskins, sanitary engineer.
2. The High Cost of Food. L. A. Congdon, M. S., Bureau of Health, Topeka.
3. Chronic Diphtheria Carriers. Dr. Sara Greenfield, Bureau of Health, Topeka.
4. Prevention of Child Mortality. Dr. Lydia DeVilbiss, M. D., Bureau of Health, Topeka.
5. A Neglected Ally of Science—Sociology. Dr. D. M. Fisk, Washburn College, Topeka.
6. Measurements of Stress in Railroad Track. C. C. Williams, University of Kansas.
7. Factors Influencing the Winterkilling of Grain Crops. Prof. S. C. Salmon.
8. Foreign Additions to Our Dietary. Prof. E. H. S. Bailey, Ph. D., Kansas University.

At 8 p. m., in Memorial Hall, the Academy was favored by a most interesting lecture on "Microbes and Disease," by John Sundwall, Ph. D., M. D., of the University of Kansas.

SATURDAY, JANUARY 13.

The Academy was called to order at 9 a. m. by the president.

The Membership Committee reported the following names for election:

Annual members: Dr. J. E. Ackert, assistant professor of zoölogy, Kansas State Agricultural College, Manhattan; W. W. Bass, A. B., physics, Manual Training Normal School, Pittsburg; Homer Blimcoe, M. S., teacher, Chapman; Robert D. Bussey, station D, Topeka; Prof. A. J. Culler, Ph. D., McPherson College, McPherson; O. B. Edison, LL. B., attorney, Topeka; S. B. Flora, Weather Bureau, Topeka; Clifford J. Hall, Emporia; T. B. Jennings, U. S. Weather Bureau, Topeka; Thomas A. Lee, A. M., attorney, Topeka; Mrs. Mary Helen Shirer Lee, Topeka; Earl O'Roke, M. A., Lawrence; F. T. Owen, Ph. D., professor of chemistry, College of Emporia; E. F. A. Reinisch, superintendent of parks, Topeka; H. C. Rule, teacher, Arcadia; Charles A. Schull, Ph. D., assistant professor of botany, University of Kansas, Lawrence; E. Claude Smith, D. O. S., Topeka; Arthur B. Sperry, Lawrence; Frank P. Strickland, jr., Kansas City; H. Wilson Swingle, Leavenworth; Arthur C. Terrill, A. M., M. E., professor of mining and ore dressing, University of Kansas; Clement C. Williams, B. S., C. E., professor of railway engineering, University of Kansas, Lawrence; E. N. Wentworth, Ph. D., professor of animal husbandry, Kansas State Agricultural College, Manhattan.

Life members: Grace E. Meeker, Ottawa; Albert B. Reagan, Ignacio, Colo.

Upon motion the rules were suspended and the secretary instructed to cast the ballot of the Academy for the nominees. The ballot was cast and all declared elected.

The Nominating Committee made the following report:

President, Frank U. Agrelius, Emporia; first vice president, L. D. Havenhill, Lawrence; second vice president, Bennett M. Allen, Lawrence; treasurer, W. A. Harshbarger, Topeka; secretary, W. W. Swingle, Topeka. Executive council: Chairman, Leroy Hughbanks, Anthony; J. A. Shirk, Pittsburg; Alva J. Smith, Emporia; J. M. McWharf, Ottawa.

By motion the rules were suspended and the secretary instructed to cast the ballot of the Academy for the nominees. The ballot being cast, the nominees were declared elected.

The Auditing Committee reported that the treasurer's report was correct as submitted. Report adopted.

Moved and seconded by Professors Agrelius and Yates that a committee be appointed to arrange a program for the semi-

centennial meeting. Motion carried. The president delegated this work to the Executive Council.

Upon motion of Professor Yates, the business session adjourned at 9:40 a. m. to 11 a. m.

Upon motion the Academy took up the reading of papers.

At 11 o'clock a. m. the business session of the Academy was resumed. The Committee on Revision of the Constitution reported that "It would appear to be the intention to add to the Executive Committee by electing more members, and that there is no difference intended between the terms Executive Committee and Executive Council." The committee also reported an amendment to the consitution. After considerable debate this was laid on the table.

The Committee on Research made the following report:

To the Academy of Science: Your Committee on Research Problems begs leave to present the following partial report:

1. In the time which has been available since the committee was appointed, a call has been sent out to the science departments of the several institutions, and to many other individuals, asking them to report upon work now in progress and work soon to be begun. The responses are submitted herewith in classified form as to subjects. There has been no time in which to work over the reports from individuals, the list submitted being almost an exact copy of the topics submitted to us. The summary attached shows the grouping.

2. It is the belief of the committee that more work should be done to bring out facts regarding (*a*) the means for doing research work in the several institutions; (*b*) problems of significance to the state, especially those not now under consideration, with a view to assigning workers to them. This should be done with the thought of interesting as many people of the state as is possible in science work.

Respectfully submitted. P. F. WALKER, *Chairman.*

Dean Sayre moved that the report be accepted and published in the Transactions and the Committee continued. Carried.

The secretary read a letter from the Illinois Academy of Science asking that a delegate be sent to their decennial meeting. Moved that such delegate be sent and that his expenses be borne by the Executive Council. Carried.

Session adjourned at 12:30 o'clock P. M.

AFTERNOON SESSION.

The Academy was called to order at 1:30 o'clock, and proceeded to the reading of papers.

At four o'clock the reading of papers was discontinued and business resumed.

The Committee on resolutions made the following report:

Resolved, That the Academy of Science sincerely appreciates the courtesy of the press of Topeka in the manner in which they have reported our sessions, and that we take this opportunity to extend to them our thanks for their many courtesies.

Resolved, That the Kansas Academy of Science give a vote of thanks to our secretary for his earnest efforts in behalf of our organization. We would especially commend the survey of the gas and oil fields of Kansas, and indorse the efforts to build up an economic museum of the industries of the state.

Resolved, That the Academy of Science heartily commend the work of Doctors Lydia DeVilbiss and Sara Greenfield in their efforts to reduce infant mortality.

Report adopted.

Professor Agrelius moved that the Academy express to Doctor Lovewell the sincere regrets of the members that he could not be with us in our sessions. Motion carried, and the secretary was instructed to write to this effect to Doctor Lovewell.

Moved and seconded that the Society of Engineers be given desk room in the offices of the Academy. Motion carried.

The Academy then adjourned.

AMERICAN HIGHWAYS.

(Address of the Retiring President, Forty-eighth Annual Meeting.)
J. A. G. Shirk.

This address has already been published in full in Bulletin No. 2 of the Academy, issued August 14, 1916.

KANSAS DURING THE ICE AGE.

(Address of the Retiring President, Forty-ninth Annual Meeting.)

J. E. Todd.

IT may safely be assumed that in a presidential address the speaker is to bring forth some fruitage of his personal research. The speaker came to the state nearly ten years ago. He had studied glacial deposits in Missouri, Iowa, Nebraska, South Dakota and North Dakota, or along the Missouri river from its mouth to Bismarck, with the exception of northeastern Kansas. Doctor Haworth soon engaged him to study the glacial deposits of Kansas, and more or less progress has been made each year since. It has been planned to finish this work the present year. Portions of the results have been already read before the Academy, namely, concerning "Drainage of the Kansas Ice Sheet," "Wakarusa Creek," and "Kaw Lake." I invite your attention on this occasion to a comprehensive, popular discussion of my subject without going into detail.

Our subject is "Kansas During the Ice Age." After a preliminary sketch of the different stages of the glacial period in North America, a short review will be given of the facts discovered, with some discussion of their correlation and significance, and finally the whole will be given in a consistent provisional history of the ice age in Kansas.

Preliminary. The Pleistocene epoch was the first epoch of the Quaternary period. It followed the Tertiary period, and closed with the beginning of the present, or recent epoch. It covered the last time when glaciers were prominent over the earth.

In North America, near the beginning of this epoch, snow accumulated many thousand feet in thickness over three centers in Canada, namely, Labrador, Kewatin (west of Hudson's bay), and in the British Columbia Rockies. From each of these centers ice sheets advanced in all directions, but especially toward the south.

Nor was this advance with one maximum or culmination, but with several, at least three or four, advances of primary rank, and more or less marked local culminations, which alternated with either recessions or perhaps disappearance of the ice.

The culminations of ice advances have been named from the states in which their deposits have been most prominent or most satisfactorily studied. Each ice sheet, or spread of the ice, left a sheet of unstratified clays, sand and bowlders, called 'till," and sometimes marginal moraines and other deposits. The stages recognized, in order of time, are:

1. Nebraskan, Jerseyan, or Albertan.
2. Kansan.
3. Illinoisan or Iowan.
4. Wisconsin, with minor subdivisions.

In the recessional stages, alternating with these, were laid down various water-laid gravels and clays, with peat beds and other organic deposits.

It should be remembered that similar deposits were forming more or less beyond the reach of the ice throughout all Pleistocene time.

SIGNIFICANT FACTS.

Topography. The region discussed is a plain about a thousand feet in altitude along the Missouri river on the east, and rising to 1,400 to 1,500 feet along the Big Blue. The bedrock consists of alternating shales and limestones of the Pennsylvanian on the east, with other strata of the Permian and Cretaceous showing in patches along the western margin.

As the prevalent dip of the strata is uniformly of a few degrees to the northwest, the rise of the general upland surface is by a succession of low, broad, gigantic steps, which have become more or less obscured by erosion and the mantle of drift which is thrown over them. The larger streams have cut down valleys 250 to 400 feet deep, and there are few square miles of the upland which are not traversed by watercourses. No basins or lakes occur except on the flood plains of the Missouri and Kansas rivers.

Limit of the Drift. The southwestern limit of drift bowlders and pebbles corresponds approximately to the Big Blue river on the west and of Kansas river on the south, or, more accurately, the line enters from Nebraska a few miles west of the Little Blue at an altitude of about 1,400 feet. It runs about that level, following the general contour southward, first a little west of Washington, thence southeast to the Big Blue, three or four miles south of Irving; thence it follows the west side of the Big Blue, declining in altitude until it reaches the vicinity

of Manhattan at about 1,175 feet. From Manhattan to Wabaunsee it follows a very irregular line at the last-mentioned level. One of the irregularities is that an old channel running west of Manhattan, past the Kansas Agricultural College, carries bowlders several miles to the southwest (and some have been reported as far away as Fort Riley). From a little east of Wabaunsee the limit runs southwest to Mill creek, near McFarland; then along that stream to Maplehill; thence southeast past Dover to the Wakarusa at Auburn; thence along that stream, with declining altitude (except south of Clinton, where it rises to nearly 1,200 feet), it leaves the state near Kansas City at an altitude less than 1,000 feet. This limit includes the drift scattered by channels, and probably lakes, leaving considerable surface within it which is driftless. At the maximum of the ice sheet the drainage of the whole western edge of the great ice sheet from Canada southward must have passed around the ice within this margin, hence, much of the marginal drift was stream-laid and probably some of it scattered in lakes.

The Limits of Till. The horizontal extent of the till cannot be very definitely determined. Though it may reach a thickness of fifty feet or more in places in the northeastern counties, further south and west it becomes very thin and patchy. It was evidently left so by the ice, but erosion has made it still more attenuated. Only scattered bowlders can now be found, where till patches may have once been a few feet in thickness.

With this qualification, the limit of typical till can be given as follows: A few miles east of Marysville, a little east of Irving, a mile west of Fostoria, three or four miles west of Wamego, four or five miles north of Paxico, four miles northeast of Topeka, about ten miles north of Lawrence, a little north of Lenape, and north and east of Kansas City, Kan.

The vertical range of till reaches 600 or 700 feet, the highest point being near Blaine at about 1,500 feet, and the lowest at Kansas City at less than 800. In the four or five northeastern counties of Kansas exposures of redrock near the upland level are rare, because the till covers all, but watercourses which have cut down 50 or 75 feet below usually show numerous exposures of older rocks with till resting on them. In the deep valleys of the creeks till is usually restricted to the higher levels, from 150 to 200 feet above the bottom of the

valleys. In the valleys of the Missouri, Kansas and Big Blue occur patches of till down to within 25 feet of the flood plain, or 40 or 50 feet above the level of the stream.

The Character of the Till. The till where it has been least weathered is a bluish gray with few bowlders and pebbles, and traversed with joints, dividing it into irregular polyhedral blocks. The joints are frequently filled with thin, chalky veins, and the adjacent till is weathered to a yellowish-brown for a thickness of half an inch or more. When the till is weathered, as in most railroad cuts, it is of dull yellowish gray. The bowlders associated with it are from 50 to 90 percent red quartzite from the well-known ledges in Minnesota. The remainder is mostly gray granite, some times much disintegrated, and greenstone of varying texture, which is usually little changed by weathering. Limestone is usually not prominent.

Distribution of Bowlders. Bowlders are remarkably abundant at several points, generally along the western margin, particularly in strips which pass north and south past Fostoria and Blaine; also six miles north of St. George, two or three miles west of Wamego, and four to six miles south of Wamego, along the east side of an old channel leading over the divide from Kansas river to Mill creek. Other very bowldery strips are found along channels leading to the Wakarusa from near Dover and Topeka.

Striæ. Comparatively few cases of striation of bedrock have been found. This is partly due to the lack of thick strata of limestone and partly to shallowness of the overlying soil. Probably surfaces which were once well striated have had the striæ removed by weathering. The following are all the cases which have been observed in Kansas, with some from adjacent territory:

Locality.	*Direction.*
Two miles southwest of Seneca	S. 21° 25° W.
Northeast of Quindaro Park, 117 feet above Missouri bottom	S. 16° W.
Near corner Twenty-fifth street and Sandusky, Kansas City, Kan, 125 feet above the Missouri	S. 12° 24° W.
Two miles east of Lenape, 125 feet above the Kansas	S. 21° E.
One mile north of St. Joseph, 125 feet above the Missouri	S. 26° W.
One mile north of Kansas City, 130 feet above river	S. 79° 24° W.
East part of Kansas City, 100 feet above river	S. and S. 6° E.

Moraines. Although several other observers have reported marginal moraines in Kansas, the writer, after examining

them, is convinced that there are no true moraines in this state. Some were reported west of Washington, but examination proved that there was only a thin scattering of bowlders over Dakota sandstone. West of Wamego and northeast of St. George are found bowldery knolls which might easily be mistaken for a subdued form of a marginal moraine, but the bowlders rest on clays which are probably Carboniferous. The knolls have been brought out by differential erosion. The wide bowldery strip on the divide south of Wamego suggests a concentration of bowlders near the edge of the ice, somewhat as a moraine is formed, but there is no accumulation of till underneath. Southwest of Topeka a few miles are a few bowldery ridges lying just east of Burnett's Mound and trending southeast. These have been quite persistently called moraines, but they are found to consist of stratified gravel, and a short distance farther south they become continuous with similar deposits lying in distinct channels. A bowldery hill near Clinton, which has been called a moraine, proved to have a similar origin.

Stream Deposits. This naturally leads us to consider stream deposits. No esker or kame deposits have been found in Kansas. All such stratified beds lie in channels and not on a ground moraine or till sheet.

The stream deposits associated with the glacial deposits of Kansas may be classified as follows:

1. Higher-level chert gravels.
2. Lower-level chert gravels.
3. Drift-filled channels, which are of three distinct kinds, viz.:
   (1) Channels filled with local drift.
   (2) Channels filled with northern drift, overridden by the ice.
   (3) Channels beyond the limits of the ice.

Higher-level Chert Gravels (Preglacial). One approaching the region from the west would first note a drop toward the east in the general upland surface. This is quite well marked and is covered with chert fragments. This is easily traced to the decomposition of several strata of flinty limestone in the lower part of the Permian. Because this chert breaks in comparatively small fragments it has been carried far eastward by various streams. As this material is insoluble and virtually indestructible, it forms a very perfect protection to the under-

lying beds; hence it forms the capping of prominent terraces along such streams as the Kansas river and Mill creek and others which flow eastward.

The highest chert beds lie from 125 to 150 feet above the level of the present streams. Along the Kansas river the chert gravels show several feet in thickness in the bottom of the old channel west and north of Manhattan. East of the Big Blue the chert lies in detached patches, one a few miles east of the Big Blue, then north and northeast of St. George, again one mile west of Wamego, and northwest and north of that place. It is extensively developed a few miles north of Rossville, and is probably nearly continuous as far as Kiro. The next clear trace of it is north of Fall Leaf, northeast of Lawrence, where it extends widely for three or four miles to the vicinity of Linwood. It is probable that traces of it may be found north of Perry and Williamstown.

An old bank of a channel marked by limestone cobbles is found near Wilder at a corresponding altitude.

Near Atchison, both south and north of the town, is a similar deposit of chert gravel only about 80 feet above the Missouri, and apparently in a channel trending northeast. The lower altitude of the deposit at Atchison agrees with the conclusion, based on other evidence, that it was in a different river system, which had a lower drainage level.

These chert gravels have never been found more than 10 feet in thickness. No northern erratics have been found within them, but they frequently rest upon it. It does not lie in a plain exactly, but varies somewhat in altitude, as we should expect if it marked not only the level of the shore or bars, but also the bottom of the ancient river.

Lower Chert Gravels. Another chert gravel deposit has been discovered and developed at several points, namely, a mile west of St. Marys, east of Rossville, north of Kingville, north of Grantville, northwest and north of Topeka. The bottom of the deposit is 25 or 30 feet above the adjacent bottom lands of the Kansas river. Northern erratics abound in the *upper* half of it, and according to the testimony of a few, they occur to the very bottom, but certainly has not been reached on that point. The gravel and sand strata show thickness of 12 or 15 feet.

Drift-filled Channels. Of these there are two sorts, one mainly filled with local material, mainly limestone; the other filled with northern erratics, consisting largely of sand and gravel. The former, we may suppose, were eroded and filled while the ice was quite distant—near enough to supply water, but too remote, or relatively too low down, to contribute much debris from the load of the glacier. The latter would be close to the ice, or so much below it that drift would be washed into the stream almost constantly.

As the ice sheet advances, streams flowing toward it will become obstructed and ponded. If such ponds fill and overflow, the material first carried by them, remote from the ice, will be of local origin. These channels are apt to be parallel with the edge of the ice, or over a divide in some other direction.

As the edge of the advancing ice sheet approaches the divide it will greatly quicken the action of streams on the further slope, especially if the melting of the ice is rapid, and it is likely to be the more rapid at first because of heat from the newly occupied earth underneath.

As the streams radiating from the advancing ice sheet are swollen the water will increase more rapidly than the debris from the ice is furnished. Two things conspire to this effect: first, the drift is apt to be coarser, and therefore soon dropped; second, the melting of the advancing glacier is more from the upper and cleaner part of the ice than in a receding glacier. As the ice recedes, though the water may increase in volume, material both fine and coarse will be likely to increase also in larger ratio.

Hence, if we have reasoned correctly, radiating streams will be eroded rapidly as the ice approaches; then they will fill up their channels as it becomes nearer. Then they may be covered with the ice and plastered over with till. Later, in the recession of the ice, streams may advance headward and follow courses approximately corresponding to which they occupied before the ice displaced them.

Of the channels filled largely with limestone bowlders we have found two interesting examples. One shows a stratum of bowlders 15 to 20 feet thick, with its bottom about 140 feet above the present Missouri. It extends for several miles along the east side of the Missouri river at Weston, Mo. Its width has not been determined. Mr. F. C. Greene, of the Missouri

Survey, informs me that similar deposits have been found further east. This is as would be expected from our theory, which may be briefly stated as follows: The ice advanced from the northeast. From buried channels and general topography it is inferred that there was a preglacial stream, probably formed by the Platte river of Nebraska, running southeast from the northwest corner of the state of Missouri and joined to the Grande river. The ice coming from the northeast would dam the Platte and pond it about the northeastern corner of Kansas. As the waters rose they would find their way southward across the divide, and as the ice moved further westward one *col* after another would be occupied until the ice should force it to find a higher one, or one that should be permanently followed, and so predetermine the course of the Missouri at that point. The bowlder deposit at Weston seems to represent such a case.

Another similar but less striking example has been noted a mile west of Bethel, on the west half of sections 30 and 31, township 10 south, range 24 east. This apparently crossed the divide between the Kansas and a former tributary of itself. It is approximately on the same level as that near Weston. The concavity of the stream bed indicates a width of about 40 yards.

Both these channels are mainly filled by blocks of limestone from ledges not far away, but mixed with them are perhaps one percent of northern erratics, such as granite and red quartzite. Both have for bedrock Carboniferous strata, and both are in the till-covered region.

The later drift-filled channels are more intimately connected with the till. Some are either underlain or overlain by it, or both. Others being beyond the limit of the till, may be more free from it than those of the earlier channels. From the nature of their relations these channels are not as readily traced. They probably exist in many places where they have not yet been discovered.

One of these drift-filled channels has been discovered east of Seneca. The sand and gravel in it appears to be 20 or 25 feet thick. It lies 60 to 80 feet above the present Nemaha, near by.

Southwest of Sabetha a few miles, and west three miles, are other gravel beds of less thickness and of uncertain relation.

So also along Walnut creek, near Padonia and east of

Hiawatha, other gravel pits have been opened of similar character and age, judging from reports.

Another class of drift-filled channels are those which are mostly beyond the edge of the till, and therefore are much more easily traced. One system of channels of this class is found in the Wakarusa valley. The channels along the north side of the system are most evident because the edge of the ice on the north abounded in northern erratics, and because they have been less subject to erosion than toward the center of the Wakarusa valley. The principal channels may be briefly traced as follows: From Dover to Auburn; another from east of Burnett's Mound, southwest of Topeka; southeastward along Linn creek; and also southward past Pauline. Other patches of larger channels are found along the Wakarusa, south and east of Clinton and southeast of Lawrence.

A somewhat similar channel, though less perfectly filled with gravel and sand, crosses over the divide four to five miles south of Wamego into the valley of Mill creek. It lies along the western edge of the bowldery strip already mentioned, and seems to have been the outlet of the Kaw lake, which will be described in the next section.

Lacustrine Deposits. From the extent of the till and of bowlders it will be seen that the ice sheet filled and crossed the trough of the Kansas river from Wamego to Lecompton. As a result a lake was formed on the west which rose nearly 200 feet above the present level of the river, or about 1,175 feet above the sea. The ice pushed into the lake on the east side, and debris from the ice, as well as material from the Big Blue and upper Kansas and other smaller streams, deposited in this lake deep deposits of sand next the edge of the ice and loesslike silts and clays further west. These beds accumulated to a depth of 100 feet or more. Bowlders were scattered over the basin up to the water level, carried either by icebergs or by shore ice. The channel northwest of Manhattan, being part of the lake, was strewn with bowlders and afterwards partly filled with loesslike silt.

Loess. A thin mantle of loamy clay covers the till in the northeastern part of the state generally. It is rarely if ever ten feet thick, except in the bluffs near the Missouri river. It there has the lighter buff color, but further west it is of a darker reddish tint and more clayey, as though it partook of

the character of the underlying Carboniferous shales. It caps some of the highest points found, and these are often near the Missouri, south of wide bottom lands. The most natural explanation of these facts is that the deposit is mostly of Eolian origin. Possibly some of its lower portion may have accumulated as dust upon the glacier ice before it disappeared. This higher loess is not marked on the map, but may be considered as covering the till generally. It is not recognizable elsewhere.

A similar deposit occurs under very different relations at lower levels along the streams, especially near the larger ones. It may reach a depth sometimes of 75 or 100 feet. It passes into sand at lower levels.

It is typically shown at Kansas City, Kan. Its lower limit is about 25 feet above the present streams. Its upper surface is terracelike, rising at Kansas City, Mo., and Kansas City, Kan., up to 150 feet above the streams. Similar deposits are found at St. Joseph and Leavenworth, also along the Kansas river at Muncie, Edwardsville, west of Holliday, at Bonner Springs, and in other places, perhaps as far west as Topeka. This lower loess, as it may be called, also has a lighter shade along the Missouri river, and a redder cast, and more clayey character along the Kansas.

It evidently is a flood deposit marking an unusually high stage of the streams, since the glaciers left this region. The term loess has also been applied to the silts deposited in Kaw lake and also to that capping lower terraces along the Kansas.

PLEISTOCENE HISTORY OF NORTHEASTERN KANSAS.

The Preglacial Stage. The higher chert gravels are believed to mark the altitude and courses of streams in preglacial time at somewhere about the beginning of the Pleistocene epoch. Accordingly, we believe that at the time the Kansas flowed from 150 to 175 feet higher than at present. Remember that the bottom of the gravels would correspond to the bottom of the present river gravels 40 feet or more below low-water mark. The course of the river ran though the channel northwest of Manhattan, thence east, as is shown on the map; always, so far as known, north of the present river as far east as Kansas City. It probably ran east as far as central Missouri.

The Big Blue and other tributaries had courses similar to those of the present time, but at higher levels.

The Missouri river was not then in existence. The northeastern part of the state, including Atchison and Seneca, probably drained northeast into the Platte-Grande river, as has been already suggested.

The Advance of the Kansan Ice Sheet. From other regions we learn that there was at least one advance of the ice before the Kansan, viz., the Nebraskan; but we have no evidence that it affected Kansas, except that streams may have deepened their channels somewhat lower than the higher-level chert gravels. After the Nebraskan ice sheet, and the following stage of Aftonian gravels, came the Kansas ice sheet, probably from the Kewatan center by way of the Des Moines valley—that is, from the northeast.

One of the first effects of this advance was the damming of the Platte-Grande river somewhere near Stanberry, Mo. The result would have been a lake, which filled the valley of the Nemaha and other streams in northeastern Kansas. The water rose until it found a way over the divide southward. This condition probably caused the bowldery stratum near Weston, Mo., inaugurating the course of the present Missouri. The bowlder-filled channel west of Bethel may have been part of a similar stream which was not permanently followed.

Later the ice advanced, causing the water to rise until higher *cols* were reached and occupied by small streams such as deposited gravels near Seneca, Sabetha, Hiawatha, and other points. The larger tributaries of the Kansas and Big Blue, augmented with more water but not at first with corresponding amounts of debris, eroded down to the level of the lower chert gravel; in them the higher gravels were rearranged at lower levels, and in the later stages, if not in the earlier, northern erratics were intermixed.

The larger streams at that time flowed about 75 to 100 feet higher than at present.

The Maximum Extent of Kansan Ice. When the ice reached its maximum extent, as has already been mentioned, it filled the trough of the Kansas river from Wamego to Lecompton and pushed on until its edge lay upon the divide south—a few miles north of the limit of the drift as already given.

Kaw lake filled and overflowed through its outlet into Mill creek, and across the next divide to Mission Creek, where, at Dover, a small stream broke over into the valley of the Waka-

rusa. Most of the water skirted the edge of the ice at Shunganunga creek, southwest of Topeka, where most of it ran over the divide past Pauline and southeast to the Wakarusa. Another stream broke over the divide near the head of Deer creek. All these are marked by bowlder-filled channels, or by terraces. They are about 100 feet higher than the present streams.

On similar evidence, though considerably less complete, we believe another lake was formed by the ice shutting off the Big Blue at Irving. This would explain the distribution of bowlders west of the Little Blue in Washington county. In this the water rose probably, for a short time only, about 1,400 feet above the sea.

As the water sought a way around through the Wakarusa valley it may have cut across the valleys and intervening divide of some southern tributaries of the Kansas. Waterfalls and rapids doubtless marked the early stages of this stream. The unusual height of bowlders south of Clinton may have been due to local ponding. The narrow valley southwest of Lawrence may have been attended with a fine waterfall, and the width of the valley just east is doubtless a result of the easy erosion of the thick Lawrence shales.

The ice sheet evidently lay so close to the bluff at Kansas City, Mo., that the Kansas river flowed for a time through the valley south of the central part of the city, although, very strangely, but few northern erratics have been found in the valley thus far.

There is some evidence that the ice sheet in Kansas was more or less lobular in form, at least after it passed over the divide into the Kansas valley. One lobe passed down the Black Vermillion to Irving, another down the Red Vermillion to Wamego, another down the Big and Little Soldier to Topeka, another down the Grasshopper to Perry, and another down the Big Stranger to Linwood and Lenape. All these, except the first, were pretty closely merged together, but between the last mentioned, which reached east of Edwardsville, and another lobe, which pushed into the western part of Kansas City, Kan., there is quite a reëntrant angle which is fairly driftless. It will be noticed that the striæ agree with this view.

The culmination of the Kansan stage did not last very long.

The age was not stationary long enough to form a moraine, and the till deposited was very thin. The ice was comparatively thin. It did not grind the underlying rocks with much pressure.

In the Aftonian gravels, which were deposited after the retreat of the Nebraskan ice sheet, in Western Iowa, there are found the fossil remains of numerous interesting mammals, including the American mammoth, one or two species of mastodon and of horses, a large bison, a musk ox, and of other subarctic animals. The remains of some of these have been found in the gravels of Kansas. For example, a mammoth tooth from near Hiawatha; a bison west of Atchison; and near Lawrence, but of uncertain age, the skull of a horse, bison and large cat; but unfortunately the exact source of these fossils has not been determined.

As we speak of the novel state of affairs of the ice age, some are curious to know how thick was the ice, whether it was clear or mixed largely with debris, and how fast it moved. Rational replies can best be given by learning what conditions exist today in a closely similar case in southern Greenland, for there the land rises to about two thousand feet above the sea, only a little higher than the region we have been considering. Those who have studied the matter inform us that above a few feet in the lower part of the ice, the ice sheet is spotless; also that its upper surface rises at the rate of from 45 to 75 feet per mile, but that the rate is greater near the edge than further back. At this rate, when the ice reached beyond Topeka at its maximum extent, at the northeastern corner of Kansas, 75 miles away, it was 3,375 to 5,600 feet thick.

The velocity of the ice at certain outlet points on the coast of Greenland has been reported from 60 to 100 feet per day. This was pouring into the sea. On the land it would move more slowly. The velocity reported was for midsummer. It is less than one-fourth as much in the wintertime.

The Recession of the Ice. For some unknown reason, whether diminished altitude or greater heat from the sun, or more carbon dioxide in the air, the climate became warmer. The ice mantle could no longer resist the withering effects of the south wind, and began soon to gradually retreat by shedding floods of water.

As soon as the edge of the ice had withdrawn from the

southern side of the trough of the Kansas river, Kaw lake found an outlet eastward and ceased to flow over into Mill creek, and the Wakarusa dwindled to an insignificant stream. The Kansas river was for a time a more magnificent stream than ever before. Lake Washington had probably emptied itself before Kaw lake began to decline.

Much of the sand and mud which had accumulated in the latter was swept away and contributed to terraces at several points in the valley below. For example, the capping of the lower chert gravels, the high terrace northwest of Lawrence and northeast of Mud creek, also south of Eudora. Meanwhile the ice had withdrawn from Kansas City, Mo., so that the Kansas and the newly formed Missouri had their present courses, but at a higher level. The most thrilling chapter of the story has been told. What remains is a rapid decline to the present commonplace conditions.

Kansas during the Illinoian and Iowan Stages. After the Kansan, the western side of the ice drained entirely through the Missouri, so far as Kansas was concerned. In other words, the Big Blue ceased to receive any drainage from the ice.

We know no reason for thinking that the streams of that time were any larger than those at present, except the Missouri, and that may have received little, for the relation of the Iowan to it has not been determined.

The streams of Kansas, therefore, simply cut down their channels, much as at present, but were still considerably higher than at present. Meanwhile the loess overlying the till was slowly accumulating.

The Wisconsin Stage. This stage saw extensive ice sheets filling the James river valley of South Dakota and the Des Moines valley in central Iowa. Both contributed largely to the Missouri.

In the recession from the Wisconsin stage the Missouri was probably greatly flooded and carried abundance of silt. This would explain the thick silt deposits, which have been called the lower loess at Kansas City. The Kansas river was swollen by backwater, and formed similar terraces on a smaller scale. This was the last prominent event of the story. With the decline of the flood closed the last chapter of the ice age, so far as Kansas was concerned.

CONCLUSION.

In conclusion, a few words on two points: First, to anticipate some questions which are apt to be asked after such discussion; second, problems which are still unsolved.

The time since the close of the Wisconsin is estimated by some to be from 10,000 to 15,000 years, and from the culmination of the Kansan ten to fifteen times that.

Chamberlain's conclusion, after a careful consideration of the rates of advance and recession of the ice, and the relations and rates of erosion of such gorges as the Niagara and the Mississippi near St. Paul, gives 20,000 to 80,000 years since the recession of the Wisconsin ice, and 300,000 to 1,360,000 since the Kansan.

Was man in existence at that time? Some claim to have evidence that men lived in North America, even in Kansas, before the close of the glacial period. The "Lansing man" has been thought by some to have lived during the recession of the Kansas ice, but at present the weight of evidence seems to show that man was not contemporaneous even with the later stages of the Wisconsin ice in North America, and that the "Lansing man" may have lived less than a thousand years ago.

Finally, it should be frankly admitted that several problems still unsolved can be pointed out:

First, we have postulated glacial lakes to explain the remotely scattered bowlders in Washington county and those of extraordinary height south of Clinton. May they not be remnants of a still older ice advance, or in other words, may they not be traces of the Nebraskan till sheet?

Second, the course of the Platte-Grande river has been only partially determined.

So also in several other cases only possibilities have been indicated, and our statements are to be taken provisionally. As the state is more and more developed, excavations will be made which may throw floods of light on these and other questions. Twenty years from now the glacial history of Kansas, we may hope, will be much clearer and more complete. I shall be satisfied if I have contributed my mite, as a pioneer explorer.

UNIVERSITY OF KANSAS, LAWRENCE.

OBSERVATIONS ON JUPITER AT THE OPPOSITION, 1915.

Edison Pettit.

THE following observations on Jupiter were begun with the Yerkes forty-inch telescope and completed with the Washburn College twelve-inch telescope and position micrometer. The observations were made (1) to determine the rotation period in various latitudes where markings of definite character might be found; (2) to determine the polar compression; (3) on the "great red spot"; (4) to measure the diameters of satellites; (5) to determine the character of any markings on the satellites.

GENERAL FEATURES.

From twenty-five observations, a map in Mercator projection was drawn. This takes system II of the Ephemeris as a basis of the longitudes. The quadrant from 180° to 270° was not well observed. Since the planet was near equinoctial, observations were confined to positions near the meridian. Powers of 750 and 1,000 were used on the forty-inch, and all observations with the twelve-inch were made with a power of 1,000. Very clear weather during October and November greatly focilitated observation. Especially clear weather was taken advantage of to measure the satellites, which otherwise flared too much.

Almost all the surface features lie between the 30° parallels of latitude. Plumelike markings were a quite prominent feature. A peculiar marking was observed on many nights in the southern band, longitude 300° to 360°, latitude —15° to —30°, like a grove of trees. Attention is especially called to two small dark spots, the following one in longitude 309.8°, latitude 15° north. This latter is especially adapted to the determination of rotation period, being small and round and of considerable depth of color. Its actual diameter is 2,100 miles, about that of the moon.

A faint line running around the planet in latitude 32° north is widened to a short, thick band in longitude 85° to 105°. This is also well adapted to the determination of the rotation period. The white spots in the neighborhood of longitude 345° were brilliant and in general of a lemon shape.

THE ROTATION PERIOD.

In measuring the rotation period both transits over the central meridian and elongations of the marking were observed. For the transit observations the double value of the equatorial diameter was measured as usual, and the micrometer set to one-fourth this value minus one-half the wire correction. As the marking approached the central meridian it was tested by setting first the right, then the left wire tangentially till the eye was satisfied that the central meridian had been reached and the time recorded to the nearest tenth of a minute. The elongation measures were reduced to the time of central transit. The reductions show that the elongations will give as accurate values of the rotation period as the transits, if the seeing is good enough to permit rapid measurement.

From an elongation of the round spot, longitude 309.8°, latitude 15.0° north, on September 21, and a transit of October 29, the value $T = 9^{h.}\ 55^{m.}\ 40.76^{s.}$, or an acceleration of $1.1^{s.}$ per degree of latitude in this region.

THE POLAR COMPRESSION.

Twenty-five observations were made for the polar compression, of which ten were rejected on plotting the risiduals. From the fifteen remaining, the value $1/17.4 \pm 1/270.3$ was obtained. This is a probable error of 6.4 percent.

THE GREAT RED SPOT.

The "great red spot" was quite distinct at times, showing a dull brick-red color. Its measured position was longitude 131.7°, latitude 23.0° south, length 29,275 miles. A peculiar group of plumes follows it. The ends of the spot had quite sharp points.

THE SATELLITES.

On two nights the images were quite free from flaring. The means of the measures are: I = 2614 mi., II = 2233 mi., III = 3908 mi., IV = 3422 mi.

Markings were observed on III and IV. Attention was especially attracted to III. On two occasions, October 21.419 and October 29.458 C. S. T., a marking was distinctly seen. The angle the straight side of the marking makes with the plane of the planet's equator being 70°. It will be noticed that the time between the observations is nearly equal to the revolution period of the satellite, which seems to indicate that the

satellite keeps the same face towards the planet during its revolution and that the marking is always turned away. It would be interesting to see if this feature is a permanent one at the coming October opposition, which will be the nearest approach of the planet in twelve years.

Washburn College Observatory, Topeka.

CELESTIAL PHOTOGRAPHY WITH THE WASHBURN TELESCOPE.

Edison Pettit.

DURING the past year preparations were made to adapt the Washburn College refractor to celestial photography. Some preliminary attempts showed that the telescope, which has an 11½-inch Brashear objective, was capable of producing good photographic images. With this in view, a double-slide plate holder was built in the college shop, which makes accurate guiding possible.

A brass collar fits over the 4½-inch draw tube, and to this is attached a brass plate which may be rotated in position angle. To this plate is attached the double-slide plate holder with guiding eyepiece and shifting screws. A plate-carrier opening in the back provides means of bringing the film to exact focus. The cross wires are No. 60 copper and illuminated with a flash-light bulb which receives current from the 11-volt a. c. telescope circuit, and may be adjusted through a potentiometer. The carrier takes 3 by 3½ in. plates.

With this form of plate holder the guiding is done on the same field of stars that is being photographed, and the corrections to the clock motion are made by shifting the whole plate and not the telescope. The field having been selected, a guiding star is found and set on the cross wires, a plate cut and inserted, and the slide cover drawn. The star is now kept on the cross by manipulating the two shifting screws, which move the plate in two directions at right angles to each other.

To facilitate photographic and other astronomical work the dome has been provided with a ½ hp. a. c. motor for revolving it. The starting box and reversing switch are placed on the side of the observing ladder, so that the observer need not leave the guiding eyepiece to shift the dome. A centrifugal friction

clutch throws on the load gradually, and gives a slow, steady motion, so that the telescope can be kept centered on the slit.

In order to make the observer entirely free at the guiding eyepiece, the driving clock was provided with an electrical winding device. The falling weight pushes a snap-switch at the end of its fall and starts a small motor receiving current from the 30-volt storage battery. This motor winds the clock through a worm gear, and requires five minutes to do the work. This makes the observer entirely free from the dome and clock, so that he need not leave the eyepiece, no matter how long the exposure.

For comet and nebular photography Seed 30 plates are used. An exposure of an hour and a half on the great nebula of Orion will give good detail. On March 17, 1915, an exposure of 2½ hours was made on Mellish comet, which showed the three nuclei into which the comet had broken as discovered by Professor Barnard five days earlier.

Plates intended for measurement must be exposed through a color filter which will transmit the visual radiations only, in order to produce sharp images. This filter is made according to the formula of Wallace. This has a bright yellow color and lengthens the time of exposure considerably. The color filter will be used to secure plates of the asteroids, the moon, and for work in visual photographic magnitudes.

Washburn College Observatory, Topeka.

NOTE ON A DEVICE FOR SETTING A HELIOSTAT IN THE MERIDIAN.

Edison Pettit.

THE DEVICE is based on the principle of Burt's solar compass. On the side of the fork carrying the revolving mirror is placed an arm carrying at one end a pinhole in a disk, and at the other a screen with a cross mark for receiving the image of the sun cast by the pinhole. This arm carries an arc graduated in 24 degree marks on either side of the line joining the pinhole and the cross, and works against a vernier arc. When this arm is perpendicular to the fork the vernier reads zero. The mirror is provided with a graduated arc which reads zero when the mirror makes an angle of 45° with the polar axis, and is graduated into 24 half-degree divisions on either side of the degree mark.

The operation of setting the instrument is as follows: The mirror arc and solar compass are both set to read the declination of the sun. Then by revolving the mirror fork about the polar axis and the whole instrument about the vertical axis, the image cast by the sun may be brought to fall on the cross. The mirror and vertical axis are then clamped and the clock started. The instrument is now in the meridian and will carry the beam of light indefinitely. An instrument constructed on this plan several years ago has demonstrated the convenience of the solar compass. A complete description of this apparatus and theory will be found in Popular Astronomy, vol. XXI, No. 9.

Washburn College Observatory, Topeka.

SOME COMMON FALLACIES ABOUT KANSAS WEATHER.

S. D. Flora.

KANSAS apparently leads all other interior states in the number of reports of adverse weather conditions and spectacular storms that have emanated from it. Being pre-eminently an agricultural state, its prosperity from year to year has depended upon its weather, and there seems to have been an unfortunate tendency from the beginning of its history to give undue publicity to the unfavorable features. We seldom hear about the unpleasant or damaging weather in other states whose climate is widely advertised, but the terms, "droughty Kansas" and "Kansas cyclone" have almost become a part of our spoken language. Even yet, a great many persons who are not familiar with the conditions have difficulty in reconciling the numerous reports of droughts and storms with the fact that the state ranks so high in per capita wealth and general prosperity.

The average annual precipitation of Kansas, which includes the moisture from rain and melted sleet and snow, ranges from forty-four inches in the southeastern county to a little more than fifteen inches along the Colorado line. Over the eastern half it equals that of Iowa, Wisconsin and Michigan, and is only a little less than that of Illinois, Indiana or Ohio, and it occurs at a more opportune time of the year than the precipitation of any of these states. From 71 to 78 percent of the annual amount for the entire state occurs in the six crop-growing months, April to September, inclusive, and there is no state in the country, except a few along the South Atlantic and Gulf coasts that, taken as a whole, receives as much rain during the summer months as the eastern third of Kansas. Even the middle third of the state receives slightly over twenty inches during these six months, which is within two inches of the amount that falls during the same period in Illinois, Indiana, Ohio, New York and the New England states, while the western third, the "semiarid region," has an average precipitation of more than sixteen inches for this period, which almost equals the amount during these six months in Michigan

and Wisconsin, and is approximately three-fourths of the average for the state of Iowa for that season of the year.

It is true that droughts occur from time to time in Kansas, but by far the greater number of them are confined to the western counties, where the chief crops are those that can be produced with light precipitation. A chart issued by the Weather Bureau shows that the occurrence of droughts during the crop-growing season in the eastern part of the state is scarcely more frequent than in Iowa, Illinois, Indiana, or even the New England states, and less frequent than over most of Wisconsin, yet none of these states is spoken of as being droughty. It is interesting to note in this connection that the combined value of the wheat and corn raised in Kansas has exceeded the combined value of these two crops in any other state more than once in recent years, and that over 50 percent of the state's yield of these is produced in the middle third, where the average annual precipitation ranges from twenty-two to thirty-two inches, and droughts (periods of thirty consecutive days or more without at least a quarter of an inch of precipitation within twenty-four hours' time) have occurred on an average of once a year in the crop season for the past twenty years.

To give Kansas credit for being the "cyclone state" is almost as erroneous as to use the term "cyclone" instead of tornado to designate these violent whirling storms with the funnel-shaped cloud. That tornadoes do occur within the state practically every year cannot be denied, but it should be considered that, while the area of the state exceeds 80,000 square miles, the path of an average storm of this character does not cover more than three square miles, and many are a great deal smaller, so that the path of one can generally be represented by a pin scratch less than an inch long on a map of the state the size of one usually given in an atlas.

In one of the most complete reports on tornadoes of the United States ever published, Prof. A. J. Henry, of the Weather Bureau, gives the total number for the eight-year period, 1889-1896, in the different states. This shows that when the relative area of the states concerned is considered, the number of tornadoes in Kansas per unit area is practically the same as the corresponding number in Iowa, and but slightly greater than the number per unit area in Illinois,

yet neither of these has Kansas's undesirable reputation for being a tornado state. In a very complete climatology of the United States issued a few years ago by the Weather Bureau, a compilation of the great disasters attributed to tornadoes in various parts of the country is given, and it is interesting to note that none of these occurred in Kansas.

Professor Henry, in his report, has deduced that even in the states where tornadoes occur most frequently, "the probability that any area 100 miles square will be visited by a tornado in any year is generally less than certainty," and further, "for any specific area or farm of one square mile the probability (of being visited by a tornado) is less than one-sixteenth of one percent per century."

During a period of twelve years for which definite information regarding the destruction by tornadoes is available, the average annual number of deaths directly due to these storms is 14, or less than the number caused by lightning, and the average annual propertly loss by these storms is insignificant when compared with the total wealth of the state or the annual loss by floods and hail, yet none of the others has attracted the notice given the damage by tornadoes.

Kansas has also a reputation for being a windy state, when as a matter of fact the most recent compilation of wind velocity records over the country shows that the winds of the eastern half of the state are not noticeably greater than those of Illinois, Indiana, or Ohio, and are less than those of Michigan, and that western Kansas is not as windy a place as western Oklahoma or the panhandle of Texas.

The roving disposition of many Kansans, who go to summer resorts in the heated periods and seek milder climates in winter, as well as a somewhat prevalent belief that the only cure for the dread disease, pulmonary tuberculosis, is the equable climate of the Southwest, has resulted in a rather widespread belief that Kansas weather is not conducive to bodily comfort and good health. We should remember in this connection that bodily comfort involves a personal equation, since the ideal climate in regard to temperature and humidity does not exist in any part of the world.

It is true that uniformity of weather from day to day is the exception in the state, and abrupt temperature changes are common, especially in winter. High afternoon temperatures

are often recorded in summer, and minimum temperatures of —10° and —20° are rather common in winter, but during the heated periods the air becomes dry, and "sensible temperatures," the ones really felt by the body, are not nearly so high as those in more humid states where the temperature seldom rises above 95°. In the western part of the state warm nights are exceedingly rare and heat prostrations almost unknown. The cold weather of winter is also rendered less disagreeable by the fact that the snowfall is light when compared with that in many other northern states.

Modern medical science has of recent years come to the conclusion that tuberculosis stands almost as good a chance of being cured in a climate like that of Kansas, other things being equal, as in the far-famed climate of the Southwest, and that Kansas climate, plus the care and rest and proper food of a good home, is much more likely to effect a cure than indifferent care in a health resort. This is not surprising in view of the fact that Kansas receives more sunshine each year than any state between it and the Atlantic, or between it and the Canadian boundary, and considerably more than what is commonly called the "Sunny South." The western third of the state is a close rival of southern California in this respect, and the air in those western counties is almost as bracing and exhilarating as it is in the mountains to the westward.

It is probable that a great deal of the well-known energy and enterprise characteristic of Kansans can be attributed to the invigorating effect of its climate, and especially the cold, dry air that sweeps across the state in winter. An eminent authority has stated, "the most vigorous people physically and the most resourceful mentally are found in the most northerly regions, that will produce not simply cereals, but an abundance of them."

Another very common fallacy about Kansas weather is that it has changed materially since the state was settled, the prairie sod broken up, and trees planted. A few years ago a person who made the assertion in the western part of the state that the rainfall was not increasing permanently from year to year would have but little credence among old settlers who had seen what had been called "The Great American Desert," producing only buffalo grass and sage brush, changed into valuable crop-producing farms.

A short time ago the writer made a rather exhaustive study of all the available long precipitation records of the state, some of which, even in the western counties, were begun more than forty years ago, and it was found on comparing the average for the last half of the records with the average for the first half, that in the western third, where the increase in precipitation had been most strenuously maintained, there had been an actual, though slight, decrease in the annual amounts since the records were begun. Some of the other parts of the state showed slight increases and some slight decreases, demonstrating that there is reason to think the change in either direction is only temporary and may be reversed within a few years.

The writer has also investigated a great deal of precipitation data trying to decide another common belief that, while the total annual precipitation may not be changing as the years pass, there is more and more a tendency for rains to fall oftener and not so much in downpours, but so far the figures fail to bear this out definitely.

A few years ago a scientist prominent in the state made the announcement that his record of wind velocity, which had been made for many years with a standard type of anemometer, showed that the movement of the wind was decreasing from year to year. The well-known ability and integrity of this man caused his statement to be widely circulated and credited. It was afterwards discovered, however, that as this man, who lived to a ripe old age, became older his anemometer had been more and more neglected and worn, with the result that its record was no longer reliable, and it was registering less wind than really blew.

The wind record at the various Weather Bureau offices of the state, unfortunately, is of very little value in settling this question, as it has been necessary so often to change the location of these offices, and it is almost out of the question to compare the records now being obtained with those of previous years; but there is nothing known to meteorologists that would lead them to believe that the wind velocity over Kansas has changed in the least in the past 500 years. It is true that a person living on the open prairie in a frail shanty would notice the wind more than after he had built a more substantial home and grown trees for a windbreak, but there are no reliable data to

show that the open prairie does not still have the same amount of wind it always had.

Another common delusion about Kansas weather is that the winters are becoming milder and the droughts less frequent and severe. This delusion I should like, personally, to find not a delusion, but it will have to give way to cold and unfeeling statistics. It is a common tendency with all of us to remember the cold winter years ago, when the snow lay deep on the ground from Christmas until spring, and the ground was frozen several feet deep, and the drought that withered the corn, forgetting the numerous favorable seasons that have passed. This has been especially true in Kansas, where the early settlers were poorly protected from the inclemencies of the weather, and still more poorly prepared in a financial way to undergo a crop failure resulting from a severe drought.

The winter of 1911-'12, only five years ago, was the coldest on the state's record, and the drought of 1913, less than 4 years ago, the most severe in the history of the state, with the possible exception of that of 1874, though doubtless many old settlers can recall winters when there was more suffering from the cold than in the one mentioned, and a great many years, especially 1860 and 1864, when the shortage of crops due to dry weather was more disastrous than in 1913.

In the light of all available knowledge, therefore, the fact seems to stand that, while Kansas has made great strides in an agricultural way in the past fifty years, and may make even greater strides in the next fifty years, the climate has not changed any since the Pilgrims landed at Plymouth Rock and will probably not change for centuries to come; also, that the golden harvests of the last twenty years have been the result of increased skill and industry in making the earth productive, and have been independent of any change in climate.

U. S. Weather Bureau, Topeka.

THE INFLUENCE OF THE SEPARATOR UPON DISTRIBUTION OF BACTERIA IN MILK AND CREAM.

L. D. Bushnell and O. W. Hunter.

INTRODUCTION.

IT IS a common practice to clarify milk by passing it through some kind of a centrifugal machine. The rapid rotation throws out most solid filth and many of the bacteria. There are at present several special machines for this purpose on the market. Some concerns consider that clarification aids the keeping quality by reducing the number of bacteria, and some milk producers think that clarification may replace pasteurization. If this is true the installation of these machines would be of value. However, special machines add to the expense of production, and we have received several inquiries as to the use of the separator for this purpose.

Beside the practical bearing of this problem upon the keeping quality of milk, a few authors have studied it in its relation to the modification of milk for infant feeding. In the latter case it is a common practice to make a modified milk by adding a certain percent of cream to skim milk. It is important, therefore, to obtain a skim milk or a cream low in bacterial content.

The results of Wilckens (1894), Anderson (1909), Stocking (1911), and Roadhouse (1914), indicate that when milk was separated, a larger percentage of microörganisms was found in the cream as compared with skim milk. On the other hand, Heinemann, Luckhardt and Hicks (1910), Swinthinbank and Newman (1903), Heinemann and Class (1911) assert that the separated milk contained a higher bacterial content than the cream. Swinthinbank and Newman estimated that 60 percent of the bacteria is thrown into the slime, 25 percent in the skim milk and 15 percent in the cream. Wilckens states that the centrifuged milk contains fewer bacteria than the original milk, and that this decrease is accounted for by the death of the cells, due to rotation. Heinemann, Luckhardt and Hicks and Roadhouse assert that the bacterial content was higher in the mixed separated milk than in the original milk. Heinemann and Class, after investigating the relation of cream to the bacterial

count, concluded that the number of bacteria in separated cream decreases proportionally as the fat content increases and the number of bacteria in separated milk decreases proportionally with the increase of fat in the cream.

The importance of this subject from the commercial, sanitary and scientific standpoints led to this investigation. Briefly stated, the object of the study was to determine:

1. The distribution of the bacteria in the cream, skim milk and bowl sediment.
2. The effect of separation upon the number of bacteria in the mixed milk.
3. The effect of different separators upon the distribution of bacteria.
4. The influence of mechanical conditions, such as the percent of butter fat in the cream, upon the distribution of bacteria.
5. The distribution of various types of bacteria by the separator.
6. The effect of distribution upon the keeping quality of the milk.

EXPERIMENTAL DATA.

The samples of unseparated milk were taken just before separating, and the samples of cream, skim milk and mixed milk just after. The time which elapsed between collecting and plating was not more than ten or fifteen minutes.

Standard plain meat-juice agar was used, and all plates incubated at room temperature for four days and counted. An average of all countable plates was taken, and the results are comparable.

In all cases the tests were run at the best conditions (speed of separator and temperature) for skimming. Care was taken to sterilize all the utensils, including all containers, separators and other utensils in streaming steam before using. This was done in order to avoid any errors which might arise from contamination and the resulting irregularity from such data.

Table I indicates what effect contamination might have upon the results. Several liters of sterile water were poured through the separator and samples of the water taken after passing from the cream spout and from the skim-milk spout of the machine.

TABLE I.

NUMBER OF TRIAL.	Bacteria per cc. in water from skim-milk spout.	Bacteria per cc. in water from cream spout.
1	30	7
2	93	105
3	113	210
4	66	241
5	8	14
6	63	57
7	19	37
8	90	136
9	96	86
10	83	61
11	37	23
12	181	162
Average per cc	73	94

A comparison of this table with those following demonstrates that the amount of contamination in every case is entirely negligible, being in fact much less than the experimental error.

The milk for the first twenty-three tests was good market milk, and for the last fifty-five tests was milk hauled in from distant farms and fairly representative of such milk. Table II gives an average of the first twenty-three tests.

TABLE II.

Number of microorganisms per cc.				
Unseparated.	Skim milk.	Cream.	Mixed Milk.	Bowl sediment.
80,000	107,500	101,100	157,900	399,800

This table shows, first, that a somewhat larger proportion of bacteria go with the skim milk than with the cream; second, that the number of bacteria in the mixed milk (after separation) is nearly double the number found in unseparated milk; and third, that the bowl sediment contains nearly five times as many bacteria per gram as does the unseparated milk per cc. This indicates that the organisms grow in masses in the whole milk, and that the usual method of estimation does not give the actual number present. The enormous centrifugal force may kill large numbers, but the counts show an actual increase. The average of fifty-five tests on a different grade of milk is given in Table III. In this series tests were not made on the bowl sediment.

TABLE III.

Number of microorganisms per cc.			
Unseparated milk.	Skim milk.	Cream.	Mixed milk.
46,383,000	45,907,000	63,813,000	*85,522,000

* The apparent discrepancy between the number of organisms in mixed milk and the number in skim milk plus cream may be explained by the unequal volumes of skim milk and cream. The entire volume of cream obtained from a single sample of milk is much smaller than the entire volume of skim milk, but we took the same volume (1 cc.) from each as a sample. When these are mixed the number in the cream is reduced, while the number in the skim milk is increased, but in unequal proportion. So that the number given for mixed milk is not a sum of the two numbers given for skim milk and cream, but is that which we actually obtained by count.

As in the former case, the mixed milk (after separating) contained nearly double the number found in the whole milk. In the first series there were larger numbers of organisms in the skim milk, but in the second series there was a marked increase in the numbers in the cream. These results are similar to those of various investigators of this problem, since some found more in the milk and others more in the cream.

Attempts were made to determine the cause of such discrepancies. Samples were taken from the spout of the separator at different intervals during the process of running the same sample of milk. Only two series of such tests were made, but these are sufficient to denote the great irregularity of the distribution of bacteria in the same sample, and indicates that testing at different times might account for the results of various investigators. Table IV shows the result.

TABLE IV.

Number of Test.	Number of microorganisms per cc.	
	Skim milk.	Cream.
1	70,000,000	160,000,000
2	55,000,000	110,000,000
3	112,000,000	240,000,000
1	64,000,000	172,000,000
2	128,000,000	125,000,000
3	189,000,000	216,000,000
4	24,000,000	362,000,000
5	104,000,000	237,000,000
6	15,000,000	168,000,000

The influence of different separators as regards the distribution of microörganisms is found in Table V. Six different machines were used and are referred to by number. The figures are an average of several trials.

TABLE V.

NUMBER OF MACHINE.	Number of microorganisms per cc.			
	Unseparated.	Skim milk.	Cream.	Mixed milk.
1	47,559,000	58,167,000	81,195,000	69,686,000
2	132,178,000	116,685,000	101,744,000	151,400,000
3	70,179,000	104,593,000	81,160,000	80,920,000
4	26,950,000	47,101,000	71,025,000	67,442,000
5	51,752,000	50,221,000	89,162,000	67,737,000
6	138,282,000	70,191,000	47,439,000	166,433,000

In every case in this table the mixed milk is higher than the unseparated milk. As to the distribution between skim milk and cream the various separators differ. In the case of numbers 2, 3, and 6 more organisms are thrown into the skim milk than into the cream. In numbers 1, 4 and 5 this distribution is reversed.

The results in tables IV and V show great variations, and it can readily be seen how different workers might logically obtain different results when only a few tests were used or by the use of different separators.

Table VI shows the relation of the amount of butter fat in cream to the distribution of bacteria. The average of the tests above 30 percent fat are designated as "high" and those below 30 as "low."

TABLE VI.

PERCENT FAT.	Number of microorganisms per cc.			
	Unseparated.	Skim milk.	Cream.	Mixed milk.
High	95,806,000	93,705,000	104,659,000	96,674,000
Low	46,387,000	45,907,000	63,813,000	85,522,000

This indicates that the amount of butter fat in milk exerts no marked effect upon the distribution of microörganisms.

An additional factor, the specific gravity of microörganisms, may account for the difference occurring in the distribution of bacteria in milk and cream. In Table II the results indicate that the majority of organisms are found in the skim milk, while in Table III the opposite is true. In the former case the milk used was fresh, while in the latter table the milk was much older. This difference in the distribution of organisms

may be explained by the greater specific gravity of the types of microörganisms found in fresh milk, in the older milk the microbial flora is different and the specific gravity lighter, thus offering better opportunity for the organisms to be carried with the cream upon separation.

In Table VII are shown the average results of twenty tests which were run to determine the relative distribution of the various groups of organisms present in milk. The plates used were litmus lactose gelatine incubated at room temperature for six days. The colonies found were grouped according to their action upon the litmus and gelatine, as follows:

(1) Acid liquefiers.
(2) Acid nonliquefiers.
(3) Alkaline liquefiers.
(4) Alkaline nonliquefiers.
(5) Neutral liquefiers.
(6) Neutral nonliquefiers.
(7) Molds.

As there appeared to be practically no difference in the distribution of the types between a milk having a low bacterial content and one having a high content, the tests were averaged irrespective of numbers.

Table VII shows that all the types predominate in the cream over the skim milk except the molds, and these are in reversed order. No conclusions could be drawn as to the distribution of the various types.

The effect of separation upon the keeping quality is roughly shown in Table VIII. The samples were taken as soon after separation as possible and kept in flasks at room temperature until about the time of coagulation, when acid determinations were made as an indication of bacterial activity.

TABLE VII.

TYPE OF ORGANISMS.	Acid liquefiers.	Acid nonliquefiers.	Alkaline liquefiers.	Alkaline nonliquefiers.	Neutral liquefiers.	Neutral nonliquefiers.	Molds.
Whole milk	6,800,000	25,296,000	12,618,000	10,738,000	19,228,000	30,964,000	24,025,000
Skim milk	7,033,000	28,623,000	8,820,000	4,311,000	15,800,000	12,082,000	19,999,000
Cream	8,200,000	46,813,000	15,387,000	11,634,000	30,150,000	32,310,000	18,126,000
Mixed milk	17,616,000	77,718,000	41,104,000	17,972,000	52,975,000	52,196,000	49,062,000
Ratio in skim milk and cream	1 to 1.16	1 to 1.64	1 to 1.51	1 to 2.7	1 to 1.81	1 to 2.67	1.09 to 1.00

TABLE VIII.

NUMBER OF SAMPLE.	Hours.	Percent acid in—			
		Whole milk.	Mixed milk.	Skim milk.	Cream.
1	43	.52	.51	.50	.49
2	92	.40	.43	.41	—
3	64	.72	.79	.57	.68
4	64	.79	.86	.73	.51
5	58	.45	.62	.52	.44
6	58	.78	.73	.68	.60
7	82	.75	.81	.65	.67
8	60	.90	.89	.95	.78
9	64	.95	.95	.80	.62
10	46	.70	.64	.50	.46
11	26	.76	.74	.72	.73
12	26	.63	.64	.67	.60
13	128	.64	.65	.69	.66
14	72	.64	.65	.69	.66

The results indicate that separation has but little effect upon the development of acid. There is a slight increase of acidity in the mixed milk over the whole milk, which denotes that the quality of the milk is not improved, except that it may be made more palatable by being freed of sediment.

SUMMARY.

1. When ordinary market milk is run through a separator more bacteria go with the cream than with the skim milk (for equal volume).

2. The bowl sediment takes out large numbers of bacteria, besides much of the solid filth.

3. Bacteria grow in masses in milk, and separation, by breaking these up, increases the numbers of bacteria (according to plate counts).

4. Different separators affect the distribution differently, some throwing more bacteria into the cream, others more into the skim milk. This, however, may vary with the same separator at different times.

5. It is suggested that the specific gravity of the bacteria influences the distribution more than the action of the butter fat, as a small or larger amount of butter fat does not materially change this distribution.

6. The keeping quality is not influenced by the separation to any appreciable extent, and so cannot be substituted for pasteurization.

7. Different methods of sampling and different time of sampling may give great discrepancy in the results obtained.

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THE MICROBIAL FLORA OF GRADED CREAM.

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A FEW years ago the state dairy commissioner of Kansas, in coöperation with several departments of the Experiment Station, undertook a systematic study of cream production. It was the aim of the investigation to devise a simple but practical method for grading the quality of cream, hoping thereby greatly to improve the general type of cream as produced throughout the state. The cream was classified into two grades, according to its acid content, that with an acidity of 0.5 percent or less being first grade, and that with an acidity over 0.5 percent being second grade. The department of bacteriology of the station determined the microbial flora of the different grades of cream, with the ultimate purpose of establishing a correlation between the microbial content of cream and its quality.

The quality of cream is inferior when it possesses undesirable flavors and odors. These can be traced to the following sources:

1. Food which the animal has eaten.
2. Absorption of odors after milking.

3. The action of microörganisms after production.

All of these sources are more or less important, but the most important flavors and odors originating in cream result from microbial activity.

The different groups of organisms common to milk can be classed into desirable and undesirable types, depending almost entirely upon their fermentation processes as related to their usefulness in dairy products. Those organisms producing agreeable flavors and odors must necessarily be considered desirable types, while those that produce disagreeable flavors, odors or changes are undesirable. The type of fermentation needed for the manufacture of each dairy product will govern the desirability of microörganisms, and on account of the large number of dairy products, the usefulness of these respective types will vary.

The microbial flora of cream consist of practically the same organisms as found in milk, and may be classified into the following groups, based upon their types of fermentation:

1. The *acid group,* represented by the common milk-souring bacteria, *Bact. lactis acidi.*
2. The *gas-producing group,* consisting primarily of the *colon-ærogenes group,* and yeasts.
3. *Gelatin liquefying group,* which is not represented by any specific organism, but usually consisting of a miscellaneous group of spore- and nonspore-producing organisms.
4. *Neutral group,* consisting of those organisms exerting no marked effect in milk.

Of these four groups only the acid group is desirable from a butter-making standpoint, all others being undesirable. If the flavors and odors common to cream result from the action of microörganisms, it seems logical to assume that a larger percentage of the desirable organisms would exist in first-grade cream than in second-grade. On the other hand, a higher percentage of undesirable organisms would probably be found in second-grade cream.

In the following classification of the types of microörganisms found in the different cream samples the lactic-acid group will always be considered the desirable type, while the yeasts, colon group, gelatin liquefiers and the neutral type will be referred to as the undesirable type.

METHOD OF PROCEDURE.

Under the direction of the state dairy commissioner, samples of cream were collected from different cream stations of the state and sent to the bacteriology laboratory for analysis. The samples were collected in sterile bottles and kept in well-iced containers until the laboratory was reached. The length of time from collection to analysis ranged from twelve to forty-eight hours. All samples analyzed reached the laboratory in good condition. As soon as received, the flavor, odor and acidity of the samples were recorded and the bacteriological examination made.

The bacteriological analysis consisted in making a quantitative estimate of the number of organisms of the different groups present in the cream. No cultural study of the different organisms was made except to demonstrate to the satisfaction of the investigators that the media used for differentiating the various groups were dependable. One cubic centimeter of the cream was diluted in sterile water blanks until the proper dilutions were obtained for inoculating plates. The following media were used for differentiating the various groups of organisms:

Litmus lactose agar for differentiating the acid-producing group from the neutral or alkaline type of organisms.
Plain gelatin for determining the number of liquefiers.
Bile lactose agar for enumerating the colon group.
Laurent's yeast media for identifying the number of yeasts.

The temperature of incubation was 37° C. for two days for all media except the gelatin plates, which were held at 18° C. for ten days.

EXPERIMENTAL DATA.

The data obtained from the few samples of cream examined during the summer this grading system was established failed to show, from a bacteriological standpoint, much in favor of this method of grading. However, the practical results obtained in the field seemed to warrant its use the following year for further study. The complete analyses of 44 samples of cream are summarized in Table 1. This gives the average of the different groups of organisms present in each grade of cream, and not the individual data obtained from each sample of cream. Table 2 shows the percentage of the desirable and undesirable types present in first- and second-grade cream.

The results indicate practically no difference between the microbial flora of the two grades of cream.

TABLE 1.

Summary of the different types of microorganisms observed in 44 samples of cream when graded into first and second-grade cream by 0.5 percent acid.

TYPE.	Number per cubic centimeter.	
	First-grade cream.	Second-grade cream.
Lactic acid type	89,000,000	57,000,000
Neutral type	76,000,000	36,000,000
Liquefying type	2,200,000	9,000,000
Colon group	100,000	250,000
Yeasts	600,000	500,000

TABLE 2.

Classification of the groups of microorganisms found in first- and second-grade cream, when 44 cream samples were graded on a 0.5 percent acidity basis.

TYPES.	First-grade cream.		Second-grade cream.	
	Number.	Percentage.	Number.	Percentage.
Desirable	89,000,000	52.6	57,000,000	55.4
Undesirable	79,900,000	47.3	45,750,000	44.5

In the summer of the following year 135 samples of cream were examined. The data are summarized in tables 3 and 4.

TABLE 3.

Summary of the different types of microorganisms observed in 135 samples of cream when graded into first and second-grade cream by 0.5 percent acidity basis.

TYPE.	First-grade cream.	Second-grade cream.
Lactic acid type	216,000,000	283,000,000
Neutral type	56,000,000	67,000,000
Liquefying type	4,400,000	3,800,000
Colon group	500,000	500,000
Yeasts	800,000	600,000

TABLE 4.

Classification of the groups of microorganisms found in first- and second-grade cream, when 135 samples were graded on a 0.5 percent acidity basis.

TYPE.	First-grade cream.		Second-grade cream.	
	Number.	Percentage.	Number.	Percentage.
Desirable	216,000,000	77.7	283,000,000	79.7
Undesirable	61,700,000	22.2	71,900,000	20.2

While the percentage of the desirable and undesirable type of microörganisms in the two grades of cream differ slightly

from those of the previous year's work, the same conclusions can be drawn. The results indicate either that the proposed method of grading does not determine the true quality of the cream, or that the microbial flora of cream has no influence on the quality. In order to determine which of these conclusions was correct the data obtained from these 135 cream samples were resummarized by classifying the samples into first- and second-grade cream according to the following methods: (1) on a 0.55 percent acidity basis; (2) on a 0.6 percent acidity basis, and (3) by flavor and odor. The results obtained by using the increased basis—that is 0.55 percent and 0.6 percent — are found summarized in tables 5, 6, 7 and 8, respectively, and are self-explanatory. A complete record of the forty-four samples analyzed the previous year was not available for reclassifying.

TABLE 5.

Summary of the different types of microorganisms observed in 135 samples of cream when graded into first- and second-grade cream by 0.55 percent acid.

TYPE.	Number per cubic centimeter.	
	First-grade cream.	Second-grade cream.
Lactic acid type	270,000,000	243,000,000
Neutral type	113,000,000	47,000,000
Liquefying type	2,100,000	2,700,000
Colon group	500,000	500,000
Yeasts	700,000	400,000

TABLE 6.

Classification of the groups of microorganisms found in first- and second-grade cream when 135 samples were graded on a 0.55 percent acidity basis.

TYPE.	First-grade cream.		Second-grade cream.	
	Number.	Percentage.	Number.	Percentage.
Desirable	270,000,000	69.8	243,000,000	82.7
Undesirable	116,300,000	30.1	50,600,000	17.2

TABLE 7.

Summary of the different types of microorganisms observed in 135 samples of cream when graded as first- and second-grade cream by 0.6 percent acid.

TYPE.	First-grade cream.	Second-grade cream.
	Number.	Number.
Lactic acid type	247,000,000	289,000,000
Neutral type	110,000,000	48,000,000
Liquefying type	3,300,000	2,700,000
Colon group	500,000	600,000
Yeasts	600,000	500,000

TABLE. 8.

Classification of the different groups of microorganisms found in the first-grade cream when 135 samples were graded on a 0.6 percent acidity basis.

TYPE.	First-grade cream.		Second-grade cream.	
	Number.	Percentage.	Number.	Percentage.
Desirable	247,000,000	68.4	289,000,000	84.8
Undesirable	114,400,000	31.5	51,800,000	15.1

Tables 9 and 10 contain the results obtained by grading according to flavor and odor. The data in this case reveal the fact that there exists a difference between the desirable and undesirable groups of organisms in the two grades of cream, in favor of the first-grade cream. This substantiates a working hypothesis that if the poor quality of cream results from the action of microörganisms a difference should be noted in the microbial content of a good and an inferior cream. It therefore follows that cream graded on an acidity basis is an incorrect means of grading in so far as quality is concerned.

TABLE 9.

Summary of the different types of microorganisms observed in 135 samples of cream when graded as first- and second-grade cream by flavor and odor.

TYPE.	Number per cubic centimeter.	
	First-grade cream.	Second-grade cream.
Lactic-acid type	299,000,000	243,000,000
Neutral type	43,000,000	98,000,000
Liquefying type	2,700,000	3,200,000
Colon group	600,000	500,000
Yeasts	600,000	400,000

TABLE 10.

Classification of the different groups of microorganisms found in first- and second-grade cream when 135 samples were graded by flavor and odor.

TYPE.	First-grade cream.		Second-grade cream.	
	Number.	Percentage.	Number.	Percentage.
Desirable	299,000,000	86.4	243,000,000	70.4
Undesirable	46,900,000	13.5	102,100,000	29.5

A summary showing the percentages of desirable and undesirable microörganisms found in first- and second-grade cream by the different methods of grading is found in table 11. Table 12 shows the number of the 135 samples examined, classified as first- or second-grade cream by the several methods

of grading. It is interesting to note that the percentage of first-grade cream increased with each increased acidity basis, but the percentage of desirable organisms decreased, while the undesirable forms increased. In the second-grade samples the converse was true.

TABLE 11.

Summary showing the average percentage of desirable and undesirable microorganisms found in the 135 samples of cream examined by the different methods of grading.

METHOD OF GRADING.	First-grade cream.		Second-grade cream.	
	Desirable.	Undesirable.	Desirable.	Undesirable.
On 0.5 percent acidity basis	77.7	22.2	79.7	20.2
On 0.55 percent acidity basis	69.8	30.1	82.7	17.2
On 0.6 percent acidity basis	68.4	31.5	84.8	15.1
On flavor or odor	86.4	13.5	70.4	29.5

TABLE 12.

Table showing how the 135 samples were classified by the different methods of grading.

METHOD OF GRADING.	First-grade cream.		Second-grade cream.	
	Number of samples.	Percentage.	Number of samples.	Percentage.
On 0.5 percent acidity basis	18	13.3	117	86.6
On 0.55 percent acidity basis	35	25.9	100	74.07
On 0.6 percent acidity basis	46	34.0	89	65.9
Flavor and odor	75	55.5	60	44.4

TABLE 13.

A summary showing a comparison of the different methods of cream grading as related to first-grade cream.

METHOD OF GRADING.	Total first-grade samples.	Number of first-grade cream samples.	Number of these samples classed as first-grade by flavor and odor.	Samples classed as second-grade cream, but considered first by flavor and odor.	
				Number.	Percentage.
On 0.5 percent acidity basis	135	18	18	57	76.0
On 0.55 percent acidity basis	135	35	27	48	64.0
On 0.6 percent acidity basis	135	46	29	46	61.3

In Table 13 it will be observed that of the total number of samples considered as first-grade cream by flavor and odor, 76 percent, 64 percent and 61.3 percent were called second-grade when graded on a 0.5 percent, 0.55 percent and 0.6 percent acidity basis, respectively. This demonstrates that grading cream on an acid basis is advantageous to the creamery men, but not to the producer. Its chief commendable feature is that

it stimulates the dairyman to produce, handle and care for his product in a more sanitary manner. This in itself is of great value and importance, but if a more perfect system of cream grading were adopted the same would apply equally as well, and the producer would receive a more just recompense for his endeavors, due to the larger percentage of first-grade cream. The establishment of a standard for grading on a flavor and odor basis is a problem for the dairy official, not the bacteriologist.

SUMMARY.

1. The quality of cream is not correctly determined when graded on an acid basis alone.

2. There is a direct relationship existing between the microbial flora and the quality of cream.

3. The quality of cream can be accurately determined by flavor and odor.

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MAN AND MICROBES.*

JOHN SUNDWALL.

I. PRIMITIVE MEDICAL PRACTICE.

SINCE the very beginning of man—and that was a long time ago—until comparatively recent times, demons and disease have been inextricably linked together in the human mind.

Archæological, historical and ethnological literatures abound with narratives respecting the relation of spirits to illness. Babylonians, Assyrians and Hindus alike held that the air was peopled by spirits, chiefly of the evil, aggressive kind, that scattered havoc and destruction among mankind. Even at this late day of boasted civilization we may state with assurance that seven-eighths of the world's population are firm believers in the demonological etiology of disease, and proceed to treat it as they did in the very earliest period of man's existence, with incantations, amulets, charms and talismans.

I shall attempt only to outline this evening the development and progress of those activities directed towards an understanding and control of the invisible destructive forces responsible for disease and death.

The oldest medical treatises known are the Petrie Papyrus, discovered near El Sahun and dated 1600 years B. C.; the Papyrus Ebers, dated about 1500 B. C.; the Berlin Medical Papyrus, dated about 1400 B. C., and the British Museum Papyrus, which was written some 1100 years B. C. In these papyri are formulæ for cures which were administered in the form of incantations and by the priest physicians. A prescription for diseases of the eye reads as follows: "Let one take a human brain and divide it in half. Let one half of it be added to honey, and the eye be annointed with this in the evening. The other half should be dried and finely ground, and it may be then used for anointing the eye in the morning."

All primitive worship of invisible forces has been directed towards some symbol, such as idols, etc. Naturally there were, to these races, good spirits who successfully combated the evil ghosts of disease. Worship of this god of cure was manifested among the Egyptians in their I-Em-Hotep, or god of medicine —a little bald-headed man. It seems that baldness and learn-

* Illustrated lecture given under the auspices of the Kansas Academy of Science, Topeka, January 12, 1917.

ing were associated even in that far distant time. It was he who assuaged the weary, who cast out the devils of disease, who gave sleep to the sleepless.

II. EARLY GREEK MEDICINE.

Since our civilization began with Greece, naturally we are more interested in the medicine of early Greece. Medical practice among the early Grecians was inextricably interwoven with its mythology. Apollo was the father of Æsculapius, who in turn was the sire of Hygeia. Hercules, Jason and Achilles were taught medicine by the centaur, Chiron. Æsculapius was the early Greek god of medicine. Like I-Em-Hotep, he was probably a man who later became apotheosized, and numerous temples were built to him. The most famous of these sanctuaries was Epidaurus. In the abaton the sick slept and were healed.

In many repects the surgeons of that period (300 B. C.) were far more determined and worked under more difficult and exciting conditions than does the modern surgeon. The surgeon of that remote date, above everything else, had to excel in physical strength and speed. For as anæsthetics were unknown, an operation was the equivalent of a battle royal, prize fight or wrestling bout. Generally the surgeon won out, but not until after several rounds had been "gone to" between the patient and himself. Further, the conflict was not always limited to the area of one ring. If the patient succeeded in breaking loose, then the element of speed came in. When the patient was overtaken the operation proceeded. Under these conditions track work might well have been one of the pre-medical requirements. Imagine a major operation being performed on the University campus. Let it begin at the Museum Building and finish at the Engineering Building, with Fraser, Snow Hall, the Gymnasium and the Geology Building as sanguinary sites of successive steps in the operation. The path followed by the frantic, unyielding patient and the benevolent, determined surgeon would be marked by a trail of red.

So much for the wonderful achievements at Epidaurus.

III. HIPPOCRATES.

Medicine in reality dates with Hippocrates, the Father of Medicine, and probably a descendant of Æsculapius. Hippocrates lived in that brilliant period of Athens when mythology

was rapidly vanishing in the light of reason. It was in that age that Pericles ruled Athens, that Socrates taught, Plato wrote, and Phidias carved his statues. Then myth and fancy began to give way to reality and fact.

Hippocrates rationalized medicine so far as it was possible in his time. He endeavored to eliminate all that was mystic, all quackery. He gave origin to the theory of the four humors of the body—blood, phlegm, black bile, and yellow bile. According to him, disease was not due to the visitation of some angered god, but to a disproportionate admixture of these humors. A practical physician was Hippocrates, for he bled, poulticed, dieted and purged his patients. He prescribed diets and recommended fresh air. Further, he was truly scientific in his bent, for he took up experimental study. Much of his knowledge of digestion was attained through feeding certain willing patients and then forcing them to vomit at definite prescribed intervals. A keen observer was Hippocrates, and some of the symptoms (Hippocratic facies) described by him are recognized in present-day diagnosis. Honor is due him for having prescribed the best code of conduct and morals that a physician can adopt—the oath of Hippocrates.

Time and space will permit us to name only the salient features in the progress of medicine from the time of Hippocrates until that period which marks the discovery of the various microbes of disease. Let us leap from one conspicuous contributor to another. After Hippocrates came Aristotle, better known for his philosophy than for his science. Then the establishment, by Alexander the Great, of the great university in Egypt. Here, while Euclid demonstrated his propositions and Ptolemy studied the moon, Erasistratus and Herophilus carried on their dissections of the human body.

IV. GALEN.

Later, we note the fall of the Alexandrian school in 414 A. D., and the center of higher learning transposed back to Europe. Rome became the center of the civilized world. Here appears the second great apostle of medicine, Galen. He was a Greek by birth, educated at Alexandria, and went to Rome, where the highest intellectual agencies began to center. While Hippocrates dominated medicine for a period of 500 years, Galen was absolute authority in medical practice for more than a thousand years. He was the first noted experimental physi-

ologist. Much of his activity was directed towards proving that the brain, instead of the heart, was the center of the nervous system. The latter view was held by Aristotle, who further held that the brain acted only as a sponge, to cool the heart. Galen cut the spinal cord of animals, which induced paralysis. He proved that the kidneys secreted urine.

With the death of Galen medicine fell a victim of the times, so far as Europe was concerned. It was buried in the long period of the Dark Ages under that reversion to mysticism, demons, incantations and charms which characterized the Dark Ages—the age when the church arrogated the sole right to be the arbiter of all knowledge. However, through one of those strange happenings, of which history is full, the contributions of Hippocrates and Galen were not entirely lost.

V. MOHAMMEDANS AND MEDICINE.

Strange to say, the saviors were those dark-faced Asians who had set out with the crescent and scimitar to annihilate the Christians. Not long after Mohammed's death, practically all of eastern Asia and northern Africa was subjugated to those who held: "There is only one God, and Mohammed is his prophet." Notwithstanding that the Mohammedans burned the immense, priceless library of Alexandria, still the Khalifs and their Arabian followers became the earnest and enthusiastic patrons of ancient and classical learning. It happened that at Constantinople there was a school known as the Nestorians, who pertinaciously clung to the old order of learning, despite the fact that the church had otherwise decreed. They were consequently banished from Constantinople, A. D. 431, and went to the valley of the Euphrates, where they founded a church and a medical school, and there proceeded to continue the study and teaching of Grecian learning. The Khalifs of Bagdad welcomed them with open arms. The Nestorians translated into the Arabian the Grecian classics, and became the teachers of Khalifs. Even the famous Haroun-al-Raschid included always a hundred learned men in his traveling retinue. Galen was translated, and was elevated almost to the dignity and rank of the Koran. The Arabs became deeply interested in chemistry—perhaps alchemy is a better term for their activities. At any rate, nitric acid, sulphuric acid and phosphorus were among their discoveries. Arabian

medicine, however, did not advance, for it was sacrilege to touch a human corpse. And without anatomy and physiology there could be little progress.

VI. MEDICINE IN THE DARK AGES.

Throughout the entire Dark Ages, when a false theology held sway, and had throttled every inception of knowledge, medicine, of course, did not advance. On the other hand, like every other science, it retrograded as a result of the unmerciful suppression given it by the hierarchy of the times. Assuredly Europe was in a state of extreme intellectual stagnation. At the end, however, of a thousand years of darkness the dawn came, and, curiously enough, it was those dark-skinned builders of mosques who contributed much to the European twilight.

Through Arabian commentators and Latin translators Europe was again given much of the knowledge that was its by birthright. Constantine, the African, translated Hippocrates and Galen. Thus Europe again became familiar with these two early master teachers of medicine.

From the tenth to the fourteenth century medicine in Europe was augmented by the immigration of Jews versed in Arabic medicine. With the fall of Constantinople, in 1453, the study of Greek was further stimulated by learned Greek scholars who migrated from that city to Rome. Then Greek manuscripts that had been buried for centuries reappeared. A discovery of the original manuscripts of Hippocrates and Galen was made. It was found that the translations of the Arabic did not entirely agree with those of the original. This led to a noted controversy, which even took a religious character. Thus did the influence and contributions of these two men serve once more to stimulate the spirit of investigation, which began with the Renaissance.

Roger Bacon, Columbus, Copernicus, the printing press—all played an important role in the revival of learning. The resurrection of the study of anatomy in the middle of the sixteenth century marks the real rebirth of medicine. Sylvius, Versalius and Fabricius each in turn contributed to the science of medicine. To Versalius in particular we owe much, for he it was who dared to ignore Galen's teachings, for the first time, and trust to his own observations. Even Sylvius con-

demned him for this disregard of authority. Following Versalius came Harvey with his monumental discovery of the circulation of the blood.

VII. THEORY OF MICROBES.

Medicine now took many avenues of progress. It is with the rôle that the microbes play in disease that we are especially concerned, and we must now limit ourselves to those activities concerned with the development of the germ theory of disease.

It was in the seventeenth century—the century made famous by Shakespeare, Bacon, Milton, Harvey, Malpighi and Galileo —that the Dutch lens maker, Leeuwenhoek, began his studies of these minute agencies of death. Perhaps the honor of the discovery of the microscope belongs to Galileo, as this instrument is so closely related to the telescope. At any rate, while he studied the firmament, Leeuwenhoek began the study of the infinitely small life forms that surround us. He saw animalculæ in water and saliva. He was interested in the origin and size of these microörganisms. Not until two hundred years afterwards however, was the great significance of Leeuwenhoek's discovery appreciated, when the relation of these invisible life forms to disease was realized.

Just when the germ theory of disease had its inception is difficult to state. Like most great truths, it was likely the growing product of many centuries. Sir Harry Johnston has said:

"Not only did the growing culture of Neolithic and early metal ages begin to preceive danger in the fly, in the locust, bug, tick and mosquito, but an instinctive dread was felt of the invisible germ, the minute organisms which were not to be visually perceived by men till the seventeenth century of the Christian era, and not to be in reality appreciated and understood till about fifteen years ago. , The instinctive belief in the "germs" and the spread of the germ diseases was undoubtedly at the basis of the preposterous class regulations developed by the Aryan invaders of a Negroid, Australoid, India."

One of the oldest specific references to the rôle that germs play in the causation of disease is found in the "De Re Rustica" of Tarentus Rusticus, who states:

"If there are any marshy places, little animals multiply, which the eye cannot discern, but which enter the body with the breath through the mouth and the nose and cause grave diseases."

Columella and Kirscher propounded the same theory even before the time of Leeuwenhoek. To the latter, however, belongs the credit of first having viewed these microörganisms.

His discoveries were not utilized until two centuries later, but numerous writers of the next century in theory taught almost precisely the relation of germs to disease. This was especially true of Plenciz and Bassi.

VIII. JENNER AND SMALLPOX.

Long before the first bacterium of disease was discovered and convicted, one of the most serious of the infectious diseases of mankind was subjugated and placed under control through the ingenuity and efforts of one man, so that now it has become one of the optional diseases. Like elective courses in the University, one may take the disease if he so desires; otherwise not. I have reference to smallpox, the great "scourge of God" that for centuries, with irregular and frequent periodicities, brought havoc upon mankind.

That vaccination for smallpox was practiced among orientals centuries ago is a verisimilitude. In all likelihood, even before the Christian era, the custom of introducing smallpox scales into the nostrils—"sowing smallpox—or of opening the pustules of the victim and transferring some of the suppuration to an incision on the one to be inoculated was practiced in Hindustan. Such practices occurred in northern Africa, among the Chinese, Persians, Circassians, Greeks and Turks. Even in northern Europe and Great Britain the principles of inoculation were doubtless known and practiced more or less sporadically and on a minimum scale for a long time.

To Lady Mary Montagu belongs the honor of introducing the practice into England on a more or less national basis. Owing to her court relations, she succeeded in converting the royalty, and when royalty once adopts a custom imitation on the part of many of its socially aspiring subjects assures its permanency. Our worthy lady had been visiting in Constantinople, and in a famous letter, 1717, she told of how she had rendered her boy immune to the disease by engrafting—a practice so common among the Turks. So enthusiastic had Lady Montagu become over the practice that upon her return to England she succeeded in converting the Princess of Wales and a host of the king's court to the procedure.

Despite these measures, the ravages of smallpox were not materially reduced. The public fought shy of vaccination. Always was the clergy ready to oppose it. "Horrid murder of the little, unoffending innocents," said the robed ecclisiastics.

Probably one child in fourteen died from smallpox. Pocked faces were as common as normal visages. Again there was a serious objection to this practice, founded upon good judgment, and that was that other diseases could be communicated from one individual to another as a consequence. Further, one never knew just to what extent the engrafted smallpox would develop.

In the year 1747 there was born in England a man who may well be placed as the third culminate in the progress of medicine—Hipocrates, Galen and Jenner. To Jenner belongs the credit for the practical elimination of the horrors of smallpox. He showed a scientific bent of mind early, studied medicine under the famous John Hunter, and while at Sodbury in practice a chance remark of a milk-maid patient was responsible for his interest and contribution to vaccinaton. During one of his visits the subject of smallpox was mentioned. She informed Jenner that to contract the disease in her case was impossible, as she had had cowpox. Again we must give credit to the peasantry for another remarkable observation. It had been known for a long time that the udders of milk cows frequently contained ulcers and pustules, and that similar lesions were transmitted to the hands of the dairymen; further that those who had contracted the cow disease were immune to smallpox.

The simple statement of the dairy maid profoundly affected Jenner. Instead of dismissing her asseverations as a mere superstition, he investigated. After extensive observations, Jenner, in 1780, confided his hopes that cowpox would prevent smallpox. In 1796 he performed his first crucial experiment. Into the abraided skin of the arm of a young man he transferred the pustular matter from the cow. Later this young man was exposed to smallpox without effect. Other experiments established the effectiveness of vaccination. From 1796 to 1823 Jenner's activities were almost solely concerned in convincing the world of the merits of vaccination. He met with bitter opposition. To transmit beastly diseases to men was considered a crime against the Most High. It was reported that bovine heads grew out at the points of vaccination. Children who had been vaccinated were reported to have developed cow faces covered with hair; others to bellow like bulls. These were among the comments of both doctors

and clergy. Jenner lived, however, to see the influential and dominating peoples in the civilized world adopt his preventive treatment. From the chance remark of a peasant to a man with an open scientific mind the world has received inestimable benefits.

To fully appreciate the value of Jenner's contribution one needs but contrast the relative indifference manifested towards the disease to-day with the terror wrought by smallpox in years gone by. The conquests of Cortez and Pizarro were accomplished more through the introduction of smallpox than by the sword. With the Spaniard's entry into South America and Mexico the disease had its inception, and then proceeded to spread like a prairie conflagration. In Mexico 3,500,000 were suddenly slain, and no one remained to bury them. Whole tribes were exterminated in the West Indies. Entire races passed away in Brazil. In Quito 100,000 Indians perished. Certain aboriginal cities were left without a single inhabitant. More terrible still were the ravages of smallpox among the red Indians. Catlin gives a very graphic account of the extermination by smallpox of the Mandan tribe, and how its great chief, Mah-to-toh-pah, the only survivor, sadly reviewed the dead bodies of his own families and warriors before throwing himself down among them, and as a result of total abstinence from food soon joined them on the happy hunting grounds.

IX. BACTERIA.

It was in 1863, two centuries or more after Leeuwenhoek saw the microbe, that the first bacterium of disease was caught and convicted by Davaine and Rayer, although it was previously suspected that this particular microbe—anthrax—was responsible for the holocaust among both cattle and men. For example, in a single district in Russia, during the period of three years, 56,000 horses, cattle and sheep and 528 men died from anthrax infection, or "wool-sorters' disease," as the human infection was termed.

The next two decades saw the discovery of many of the bacteria that are the enemies of man. Microörganisms that enter man, and as a consequence cause diseases, are known as pathogenic. They may belong, so far as can be determined, to either the animal or the vegetable kingdom. The former are referred to as pathogenic protozoa, while the latter are

termed pathogenic bacteria. Even now some question has arisen as to whether bacteria should be classed solely among plant life. At any rate, bacteria are extremely minute. Only the highest power of the microscope can detect them. For them a pin point would make a plateau. In some species 15,000 to 20,000 could stand "shoulder to shoulder" in a straight line and still be within the limits of an inch. One million would not weigh a gram.

No other species of life forms are so ubiquitous. Earth, air and water are the abodes of countless billions. Even snow and ice are their rendezvous. One pint of milk contains millions. We drink and inhale thousands upon thousands daily.

Bacteria propagate by simply dividing. Should one divide to form two new lives, let us say every hour, then 16,613,376 would be the number of progeny at the end of twenty-four hours. It has been estimated that a cholera germ divides every twenty minutes. At this rate five quintillions could claim lineal descent from this prolific ancestor in twenty-four hours. If all bacteria were permitted to indulge in such prolificacy, there would be no room on the face of the earth for other life forms. Fortunately, environment, competition and food supply do not permit of this luxuriant and riotous growth.

Only relatively few bacteria are pathogenic to the human body. Otherwise human life would be impossible. Many species are among man's greatest industrial servants. They till the soil; they serve man in the jute and flax industry; they help to tan; they put aroma into tobacco; wine, beer and vinegar are the products of their activity. Luscious fruits, cheese and butter are flavored by them. Even our daily bread is a product of their noteworthy labors.

Pathogenic bacteria, to repeat, are those members of this important group of life which are destructive to animal life. They flourish and multiply in the protoplasm of animal life. When once an entrance is made into the living flesh they begin to multiply and destroy that in which they grow.

The pathogenic bacteria, as a rule, are classified according to their forms. The slightly elongated, straight, rod-like forms are termed bacilli. If the elongated ones are spirally shaped, then they are called spirilli. Many species of bacteria are spherical in outline, and are known as cocci.

X. PASTEUR.

In 1863, the year of the discovery of the anthrax bacilli, Louis Pasteur turned his attentions toward the study of this disease. To him we are far more indebted than to any one else for the comforts and well-being of humanity to-day. Pasteur was the sower of the modern ideas of medicine. Our practices of asepsis, antisepsis, and vaccinations against destructive diseases are the direct results of the brilliant experiments of this master mind. Certainly Pasteur may be regarded as the modern god of medicine.

Until the entrance of Pasteur into the scientific arena the world was laboring under a false delusion, and one of momentous significance. I have reference to that predominating theory of that time, that life originated spontaneously. The Greeks and Romans firmly held this view. Virgil taught us how to make bees. Aristotle taught that frogs and eels could develop from dead matter. Van Helmont, in the seventeenth century, gives us a prescription for making mice: "If soiled linen be squeezed into the mouth of a vessel containing some grains of wheat, the grains are transmitted into adult mice in about twenty-one days." "To produce scorpions," wrote Van Helmont, "scoop out a hole in a brick. Put into it some sweet basil, crushed. Lay a second brick upon the first, so that the hole may be perfectly covered. Expose the two bricks to the sun, and at the end of a few days the smell of sweet basil, acting as a ferment, will change the herb into real scorpions." Even in our own day some people really believe that mice develop from old rags. How mussels develop from mud, and worms from rotten timberwood which later become butterflies, and then in turn birds, were frequently described in type. Even as late in 1858, Pouchet published a "Note on Vegetable and Animal Protoörganisms Spontaneously Germinated in Artificial Air and Oxygen."

Among thinking men an intense controversy raged throughout the eighteenth and nineteenth centuries respecting this point. The experiments of Father Needham, Abbe Spallanzanni, Schwann, Helmholtz, Schroeder and Dusch, among others, certainly strongly suggested that spontaneous origin of life did not occur.

It was not until 1862 that Pasteur proved conclusively to a skeptical gathering at the French Academy of Science that "*la*

génération spontanée est une chimère." Now "*omne vivum ex ovo*" and "*Omne vivum ex vivo*" are biological axioms. The practical significance of this very valuable contribution of Pasteur will be considered later.

Pasteur was a chemist by training and had devoted much time to the study of fermentation in beers and wines. Especially was he concerned with the determination of those factors responsible for these diseased liquors. He became convinced, as a result of his studies, that the fermentation of beer and wine and the souring of milk were due to the activity of living microörganisms. Although this view had been previously surmised, it remained for Pasteur to bring this truth to its full realization. He even suggested that decay, disease and suppuration were fermentive processes analogous to that in wine. Thus from studies concerned with those articles toward which the bone-dry measure is directed has the happiness and health of mankind been materially increased.

Pasteur next took to the study of anthrax, which had been only recently discovered. He found that it would flourish and multiply in an environment other than blood. He made beef extracts or bouillons, into which he planted the anthrax germs. He noted that in a short time this medium became filled with the swarming bacilli. He studied the effects of temperature, and found that upon addition of certain chemicals the anthrax became less poisonous or attenuated. These attenuated cultures were then inoculated into animals, with the result that the animal became extremely sick, but did not die as was the case when the virulent bacilli were introduced. Later he found that an animal which had been inoculated with the attenuated forms and recovered could withstand a more virulent dose upon a second inoculation. After recovery from the second dose the most virulent cultures of anthrax were ineffective. Thus was the principle of immunity developed and established. As soon as Pasteur had perfected this technique of producing immunity, he announced his discovery to the world. Its reception, like all great truths suddenly advanced, was met by the most contumelious contravention. A commission was appointed to investigate the apparently absurd claims of this French chemist. Was he a charlatan who desired to work his mystic wares upon an ignorant and credulous public? France lost yearly millions of dollars as a result of the havoc reaped

by anthrax. What could stop such waste other than an act of Providence?

From Pasteur's own notes we learn that, "On May 5, 1881, twenty-four sheep, one goat and six cows were inoculated with an attenuated form of anthrax. On the following May 7, these were reinoculated with a more virulent culture. On May 31, the same animals were again inoculated with the most virulent bacilli, along with a corresponding number of animals which had not been previously inoculated. Two days later he had the extreme satisfaction of demonstrating to the commission the results of his experiment. Not one of the immune animals demonstrated the least signs of infection, while in the nontreated group all were either dead or seriously affected.

The most fascinating, if not the most romantic of Pasteur's labors, were associated with the conquest of hydrophobia or rabies. The appalling effects of the mad dog's bite has been known since time immemorial. One of Homer's warriors calls Hector a mad dog. Aristotle described the disease. Celsus recommended that a victim of the bite be held under water until almost drowned. Van Helmont, he of mice-making fame, recommended that Celsus's treatment be applied until the whole Psalm "Miserere" be sung. Perhaps in some instances it would be far more pleasant, even unto death, to be fully immersed during the vocal execution of the Miserere by some tremulous prima donna. Still such a procedure could never be made a standardized practice.

Many other therapeutic measures had been devised for rabies. Bleeding the patient nigh unto death, starvation, or both of these procedures combined, a diet of mad dog's liver, and drinking the blood of the mad dog, were some of the practices in vogue. One of the most common practices was suffocation. Either the victim was drowned or suffocated, by some such means as compression between two mattresses. As late as 1810 France passed a law prohibiting drowning or suffocation of hydrophobia victims. It is impossible for us in this day to realize the extreme horror with which the disease was held. Always regarded as incurable, it was a frequent practice for parents to lead the child who had been bitten to some pond or stream and there drown it. Such customs were by no means uncommon in Europe up until the time when Pasteur turned his attention to the study of rabies, in 1880.

No doubt the memory of a rabid wolf that attacked and killed a host of Pasteur's associates when he was a child of eight years impelled him to begin its study. He soon demonstrated that the poison introduced by the diseased mad dog located itself in the brain and cord, and that by making emulsions of the central nervous system of dogs dead from rabies, and inoculating the emulsion into the brains of normal dogs, the latter would contract the disease in fourteen days. Likewise he gave the disease to rabbits, and further learned that after successive inoculations of rabbits the infectious agent in hydrophobia became ever so much more virulent. By drying the spinal cord or brain removed from the rabid rabbit, the virulence would decrease daily until the fourteenth day, when it would entirely disappear.

With this knowledge gained after much patient study, Pasteur began his famous production of immunity. He made emulsions of the fourteen days' dried rabid cord, now innocuous, and injected it into a normal dog. The next day an emulsion of thirteen days' dried rabid cord was inoculated into this dog. On the third day a twelve-day cord was likewise injected, and so on until the dog had received fourteen injections of cords varying from fourteen days old to one day old. Each succeeding inoculation was thus more virulent than the preceding. It was soon demonstrated that a dog so treated was impervious to hydrophobia. The most rabid dogs were permitted to lacerate these treated dogs, without effect. Pasteur, in March, 1885, announced to the scientific world that he had succeeded in producing dogs immune to hydrophobia, and on July 6, following, little Joseph Meister was bitten. Pasteur utilized his method of producing immunity in dogs and began the famous treatment of the boy. Madame Pasteur's account of his conduct during this experiment is most interesting. Almost wrecked with apprehension, he continued the treatment while little Jo played with the rabbits and guinea pigs in the laboratory. The boy did not develop the disease, and became the first successfully treated patient for hydrophobia in history.

As knowledge becomes more or less universal, the contributions of Pasteur will be generally heralded as the most priceless of all the contributions made by that galaxy of great men to whom the world is indebted for its welfare and progress.

XI. LISTER AND ANTISEPSIS.

Until this time no attempts were made to clean and sterilize wounds. If the foul, deadly suppuration was due to some reaction between exposed flesh and air, why should concern be manifested towards maintaining a clean wound? A scratch in that day was as fatal as a bullet wound of to-day. One needs but to familiarize himself with surgical history of former European wars to realize the enormity of infection. It is said that during Napoleon's campaigns it was found to be far more expedient to place slightly wounded soldiers—soldiers with wounds which in this day would be regarded as trivial, and would not greatly incapacitate them—before the firing squad. Dead soldiers were far more valuable than infected soldiers. Our greatest human catastrophies of the Civil War were ones of infection. Practically every head and abdominal wound proved fatal. A driver of one of the ambulances in that war was asked if he knew how to treat wounded men. "Oh, yes," he replied, "if they are hit here (pointing to the abdomen), knock 'em on the head."

Then for years there was the great waste of life in both private and hospital practice. Hospitals were known as veritable houses of death, and, like Dante's Inferno, the gates might well have borne these words in somber color: "All hope abandon, ye who enter in." Great loss of life was especially experienced in the lying-in hospitals, where practically every mother, after giving birth to her offspring, left the wards in coffins. In the Munich *krankenhaus* 80 percent of all wounded became gangrenous. In 1868 the death rate alone for amputations was 60 percent. Lingo Porto, a famous Italian surgeon, regarded the patients in his hospital chiefly as material for his museum.

Such was the indescribable horror of the day when microbes were considered the direct products of reaction between air and flesh.

Following up Pasteur's incontrovertible demonstration, Lord Lister began his famous studies of asepsis and antisepsis. Carbolic acid was found to be a splendid antiseptic, and as a result of the untiring efforts of this man, who had obtained the master idea from Pasteur, humanity to-day sits firmly ensconced with wounds which formerly would have been fatal, but now are regarded as nothing more than temporarily inconvenient.

XII. FAMOUS PATHOGENIC BACTERIA.

In 1867 one of the most important of pathogenic germs—streptococcus—was caught red handed. In association with other germs, it is responsible for suppuration, which once caused so much destruction of life. Now we know that several species of streptococci exist, and that they are largely responsible for such serious diseases as tonsilitis; endocarditis, in which the valves of the heart are destroyed; and arthritis.

Staphylococcus, an intimate associate of the streptococcus in wound infections, was not discovered until the years 1884 and 1885.

The *Bacillus lepræ* was discovered by Hansen, of Bergen, in 1872, and now it is universally recognized as the cause of leprosy. The disease appears to have prevailed in Egypt 3000 to 4000 B. C. The Hebrew writers frequently refer to it. India, China, Greece and Rome in ancient times were familiar with the disease. It appears to have reached its culmination during the Middle Ages, when it was prevalent all over Europe. It is said that there were at least 20,000 leper asylums during the sixteenth century. Since then the disease has greatly declined. To-day it is more or less confined to China, Australasia, the Philippines, the Sandwich Islands, West Indies, Mexico, Norway, Sweden and Russia. The bacillus resembles in many respects the tubercle bacillus. Contrary to the general belief, it is not highly contagious.

The spirillum of relapsing fever, so common to the southern Russian peasants, was first seen in the blood of its victims in 1873.

Many microbes depend upon some kind of carrier for their preservation and deposition into living flesh. Usually these carriers are insects, such as flies, mosquitoes, lice, ticks and bed bugs. The microbe patiently lives within the intestines of their carriers until the latter find their victim. Then as the carrier proceeds to fill up on the blood of the victim, the microbe makes its double-quick entry into the circulation of man and begins to propagate in this new and conducive environment. In case of relapsing fever the bed bug serves as the carrier.

The *Diplococcus intracellularis* was discovered and described by Weichselbaum in 1877. Since then this germ has been found to be the etiological factor in epidemic cerebrospinal

miningitis, which is a very fatal disease. At least four serious outbreaks have been recorded. During the first period, 1805 to 1830, the disease was very prevalent in the United States. The second period, 1837 to 1850, was marked by a serious epidemic in France. During the third period, 1854 to 1874, an outbreak occurred in both the United States and France. The fourth period began with 1875 and continued up until recent years. There have been many serious epidemics in different places during this period. Much credit is due Flexner and his collaborators for an antimeningococci serum which has proved to be efficacious in many cases in the treatment of the disease.

In the early eighties a number of the most destructive bacteria were isolated. In 1880 the bacillus of typhoid fever was discovered. This dreaded disease has doubtless claimed millions of victims in the past, and even to-day approximately 180,000 people in the United States annually suffer from the infection. At least 18,000 die as a direct result of the disease. We cannot even conjecture how many die or are impaired for life from the indirect results of these minute engines of destruction. Typhoid fever and war have always been inextricably associated. This fever was the chief source of our fatality during the Spanish-American War.

With the discovery and isolation of a specific microbe, many phases of study must be devoted to it. Its resistance, growth and methods of dissemination are some of the important aspects from which it is considered. We have learned so much regarding the habits and habitats of the typhoid bacillus, and ways of preventing contamination therefrom, that we may now regard it, like smallpox, as an optional disease. We know that it is strictly a human infectious organism, and that it confines its chief destructive activities to the intestinal tract. It may live for a long time in water and the damp earth. As it is specifically a human disease, typhoid bacilli must always have their origin from human excrement. It is a well-known fact that one who has recovered from the disease may continue to carry and disseminate typhoid bacilli for years afterward. Man, running water and flies are some of the chief agencies of dissemination. Infection can only occur through ingestion. Water, milk, vegetables or prepared foods that have become contaminated through the agencies of man or flies are the chief sources by which infection occurs. To obviate all these sources

of dissemination and to destroy all contamination which may have occurred of the food and water taken into the system is a positive insurance against typhoid fever. An additional precautionary measure is vaccination—one of the great accomplishments of the age based upon Pasteur's master contribution.

XIII. ROBERT KOCH.

In 1881 another genius entered the field of disease conquest. Robert Koch was a country physician, and when his remarkable work in bacteriology was begun he possessed none of the equipment we now regard as indispensable to its study; yet Koch's achievements have never been equaled. He has rightly been called the Father of Bacteriology. It was he who ferreted out perhaps the most destructive of all these minute missiles of death—the tubercle bacillus, which he discovered in 1882. Up until the time that Koch magnanimously presented to mankind the results of his inestimable labors, tuberculosis was the most despairing of diseases. That the disease is heritable was the universal conception, and as a consequence family after family for generations unnumbered were exterminated. It seemed useless to attempt to combat its insidious onslaughts when the disease was considered theirs by hereditary transmission.

A most resistant germ is the tubercle bacillus. It may live for months in dark places. It resists to some extent both the warm, dry, penetrating rays of the sun or the temperatures of ice and snow. Its chief portal of entrance is the respiratory tract, although the mouth also is a highway of the ingression. The bacilli may enter through abrasions in the skin. The chief source of dissemination is from the consumptive himself. With each careless expectoration millions of germs are released, which await other victims. When the sputum dessicates, the microbes firmly ensconce themselves upon veritable aëroplanes of dust particles. The wind or the broom of the good housewife then sends them on their journeys of destruction. They may gain entrance into the mouths of babes as a result of the omnivorous habits infants have of sucking every prehensible object, no matter the extent of contamination. No wonder, then, that the disease was regarded as fundamentally a heritage. Again, tubercle bacilli may enter the digestive tracts of infants through milk from infected cows. It is now generally held that bovine tuberculosis is pathogenic to man.

Nor must we forget the role that the filthy house fly plays in transferring the germs from infected sputum to food.

The tubercle is both aristocrat and proletariat, as it attacks both rich and poor alike. Spinoza philosophized while his very lungs were being devoured. Likewise Schiller, Sterne and Keats were early victims of the disease. Stevenson's years were early numbered, and Chopin composed his own funeral march to the note and rhythm of the invincible and fatal advance of these minute destroyers within his body.

Propably one million and a half of the world's population succumbs annually to tuberculosis. The mortalities at the Marne, the Somme and Verdun, excruciating as they have been to our sense of humanity, do not equal in numbers the yearly victims of tuberculosis. In the United States alone 150,000 are destroyed. With what horror and wrath would we receive word that 100,000 of our young men had been slain in France! Yet at our very doors murder of even more gigantic proportions goes on, and with every victim countless millions of destructive mines are sown which only await the unsuspecting passer-by.

As a result of Koch's triumph, and a host of workers who have followed him in the investigation of tuberculosis, the disease has been robbed of much of its terrors. We no longer regard it as a heritage. Further, we have learned that cleanliness, fresh air, sunlight, substantial food and the maintenance of high bodily resistance are the catholicons of prevention and cure. All patent medicines purporting cure should be shunned.

In 1886 cholera began its sixth gigantic and destructive march from Asia into Europe. Cities were left without a single inhabitant. When it was heralded in Europe that cholera had once more broken out and was running amuck, a number of young scientists went to Alexandria with a view of determining its etiology and combating the disease. Quiller, one of the great martyrs to man's welfare, lost his life. It was Koch who first isolated the germ—the comma bacillus of cholera. He then went to India, the breeding hole of this microbe, and there offered his services to the British government. He was not well received; the attitude of the officials there was one of wonder why a German scientist should concern himself with British affairs. At the present time there

might be some reason for such a reception, but at that time it was inexcusable. Discouraged, Koch returned to Germany, and even there his claim of discovery of the specific microbe concerned in cholera was met with scepticism and derision. Even Professor Pettenkofer, a famous bacteriologist, refused to accept the apparently harmless little comma bacillus as being responsible for the dreaded cholera. To prove his contempt for Koch's claim, it is said, he drank a suspension of the germs—a veritable cholera high ball. After a lingering and almost fatal illness, Pettinkoffer fortunately recovered—needless to say, converted to the efficacy and specificity of Koch's germ in the production of cholera.

Cholera is closely akin to typhoid fever, but much more fatal in its effects. Its origin, its methods of dissemination and its means of entrance are similar to that of the typhoid bacillus. It is specifically a human disease. The average annual mortality from this disease for the years 1898 to 1907 in India was 336,378. Much credit is due Haffkine, Nicholi and others, who have studied the germs and developed a vaccine for the disease. According to one report, among 40,000 who have been vaccinated only six contracted the disease.

Perhaps the most spectacular of all microbes is the one discovered by Kitasato, and responsible for bubonic plague. *Bacillus pestis* is the term applied to this particular germ. From time immemorial this pestilence has existed. In Samuel we find biblical reference to its occurrence among the Philistines. The world has passed through three great epidemics of plague. The first originated at Pelusium, in Egypt, in 542 A. D. By following the great trade routes, it soon spread by one route to Alexandria on the north, and by another into Asia, and then to all the known world. At the height of this epidemic, according to Procopius, an observer, from 5,000 to 10,000 died daily.

The second great epidemic of plague is known in history as the black death. It originated, so far as can be determined, in Mesopotamia about the middle of the eleventh century. It is thought that the returning Crusaders during the twelfth and thirteenth centuries assisted in its recrudescence. Again the disease followed the trade routes, and this time it penetrated even farther into Europe. During the epidemic some 25,000,000 people, or one-fourth of the population of Europe, per-

ished. It is said that at the siege of Gaffa, in Crimea, by the Tartars, 1346, the city appeared impregnable. In the meantime plague broke out among the besiegers, and to them apparently the city was lost. Suddenly it occurred to one of the besieging generals to throw into the defiant city, by means of a catapult, a dead victim of plague. The disease spread like wildfire among the besieged. This act alone caused the fall of Gaffa, and from there the plague was carried to Constantinople by the escaping besieged.

At present there still exists the smoldering remnants of the third epidemic of plague which originated in China in 1871. From there it spread to India, where 6,000,000 natives died within the period of ten years. It has appeared in the principal seaports of the world since then. Only two years ago it appeared in New Orleans. The vigilant activities of the United States Public Health Service soon stamped it out.

Plague is primarily a rat infection, and is transferred from this animal to man by the flea. Eradication of these two carriers will assure man's freedom from this fatal infection.

XIV. DIPHTHERIA AND TETANUS.

The decade following 1880 was remarkable for the discovery of many of the important pathogenic bacteria. In 1883 Klebs found in the false membrane of the throats of children, who had been choked to death from the extremely prevalent and dreaded infection known as diphtheria, the specific germ responsible for the disease. The year following Loeffler found that he could produce the disease in rabbits and guinea pigs. He learned, however, that it was first essential to abraid or scarify the mucous membrane of the throats before the animals would contract the disease. A noteworthy observation this was, for from it we have learned of the dangers of colds. Colds, like the experimental scarification of Loeffler's, break the continuity of the protective mucous membrane and permit other dangerous germs to gain entrance into the system. Therefore, a cold may be the forerunner of tuberculosis, scarlet fever, diphtheria or other serious and fatal infections.

During the time that Klebs and Loeffler were busy with experiments regarding the diphtheria bacillus and its habits, Von Behring and Kitasato isolated the peculiar drum-stick-like bacillus which is responsible for lockjaw or tetanus. This germ

has a wide distribution, and its spores are found wherever there is dirt. Barnyards are veritable repositories for them. Rusty nails appear to be rendezvous. Even the dirt that besmears the healthy living child may contain millions of these spores of tetanus bacilli. The spores can only grow when they gain deep entrance into the body and are shut off from oxygen.

It is known as the Fourth of July bacillus. It was once a custom to exhibit our copious and excessive patriotism with every form of pyrotechnic art. Frequently, premature explosions of the firecrackers, etc., drove the accumulated dirt on the hand, with its numerous spores, deep into the skin, and, as a rule, the obituary column of the local press within a few days would announce the subsequent fate of many of our little patriots. Tetanus has been responsible for immense loss in the livestock industry as well.

The tetanus bacilli was duly convicted by Von Behring and Kitasato as being responsible for lockjaw. But the bewildering problem to them was, How did it accomplish its dire results? It will be recalled that Davaine and Rayer found the blood of anthrax victims swarming with the microbes—a condition sufficient to account for the relation of the germ to the disease. Not so, however, in the case of tetanus. The most diligent search failed to reveal the germ in the blood of their victims. How, then, did it act in its murderous onslaughts? Further study and experimentation proved that the germ in itself was more or less innocuous, but that its excretion, or the by-products of its metabolism, was the real poisonous agent. This led to a new conception of the destructive action of pathogenic bacteria. It is not the presence of bacteria in themselves that kills, but the poison, or toxin, they produce or eliminate as a result of their growing activities.

It is, then, the toxin from tetanus that slays. The poison is absorbed by the blood and carried to those vital centers in the brain and cord, and there irritates and paralyzes the nerves which control the muscles and vital organs. Tetanus toxin is in all probability the most poisonous agency known. A fatal dose of strychnine ranges from 30 to 100 milligrams, while .23 milligram of the tetanus toxin proves fatal. In other words, it is from 120 to 400 times more poisonous than strychnine. A drop or two of this poison injected into the elephant would result in its death.

The admiration and gratitude of the world are due these modest, indefatigable pioneers in medicine. As soon as some new truth was ascertained it was published without material gain. Thus ideas were exchanged and great progress was made. Contrast this spirit with the modern commercial patents now granted for any and all insignificant devices.

As soon as Klebs and Loeffler learned of this idea of toxins from Von Behring and Kitasato, their perplexities were ended, for they could find the diphtheria bacilli in the throats of the victims, but never in the blood.

Von Behring and Kitasato, acting upon Pasteur's inspiration and suggestion, developed immunity for tetanus. This was accomplished in a manner much similar to that utilized by Pasteur—first attenuation of the poisonous toxin followed by repeated, increasing injections of the toxin into the blood. After this has been accomplished in the case of one animal it can successfully withstand a dose of toxin that is sufficient to kill a thousand like animals which have not been immunized. Later, it was learned that the blood of the immunized animals would, when injected into normal animals, cause immunity. Here, then, we have the discovery of another great principle of modern medicine, and that is, in the case of tetanus, that the blood or serum of an animal which has been immunized by repeated, increasing injections of toxin, will cause another animal to become immune when this sensitized serum is injected into it. This serum is known as antitoxin.

After this great discovery had been magnanimously heralded to the world, we find that the next great triumphal advance came from across the Rhine. Roux and Yersen, in Pasteur's laboratories, began their monumental labors in the study of diphtheria. With the idea of antitoxin contributed by Von Behring and Kitasato, they set out to ascertain if diphtheria would react in a like manner. It was found that such was the case. However, twelve long years of labor passed before the most suitable animal was found in which to develop the antitoxin. Ultimately the horse proved to be that animal, and now thousands of horses are used for this purpose. The process of making the antitoxin in brief is as follows: The diphtheria bacilli in countless billions are grown in a bouillon. When sufficient toxin has developed they are destroyed by heat. The

bouillon is then filtered, and the filtrate, which contains the toxin, is then used in producing the immunity. At first a very small amount of diluted toxin is injected into the horse. After it recovers from this inoculation a second larger and more virulent injection of toxin is introduced. Recovery from this second is followed by a third injection of still larger proportions, and so on until the horse reaches the desired immunity. Then a certain amount of blood is drawn from it. The serum which contains the antitoxin bodies is separated off from the other elements of the blood and distributed as diphtheria antitoxin.

Of the inestimable value of Roux and Yersen's contribution little need be said, for the majority of us remember the extreme apprehension caused by diphtheria epidemics prior to 1896, when Roux and Yersen gave antitoxin to humanity. In those days diphtheria and death were almost synonymous terms. Especially severe was this disease in such cities as Paris, Odessa and Rome. When some little member of the household began to show signs of the development of the false membrane in the throat, it was led away by an officer of the law to some isolation hospital. The fond parents had little upon which to base any hope of its being brought back to them in life. Assuredly Roux and Yersen have robbed diphtheria of its horrors.

XV. PNEUMONIA AND INFLUENZA.

Another representative pathogenic bacterium is the pneumococcus, which is the chief etiological factor concerned in pneumonia. In old age especially is the disease almost invariably fatal. The longer one lives the greater are the chances that pneumonia will usher one out of this world of action. Efforts, and with some degree of success, are being made to develop a vaccine both for the prevention and cure of pneumonia. If this is successfully accomplished the span of life should be materially increased.

The bacillus responsible for influenza or la grippe was isolated by Pfeiffer in 1892. Great pandemics of this disease have been recognized since the sixteenth century. There were four, with their succeeding epidemics, during the last century. The last pandemic seems to have begun in the East. According to Osler, it prevailed in Buchara in May, 1889. It reached Moscow during the following September, St. Petersburg in October,

Berlin in November, London during the middle of December, and by the end of this month it had reached New York. The duration of an epidemic in any one locality is about six weeks. There is no disease of modern times that attacks indiscriminately so large a portion of the inhabitants. Fortunately the mortality is low.

XVI. CARRIERS OF DISEASE.

Already the relation of the bed bug to relapsing fever has been mentioned. The flea has been convicted of inoculating mankind with the black death. The cockroach, along with the fly, is now being accused of being an active agent in promiscuously scattering the destructive seeds of typhoid fever and tuberculosis. The stable fly is now being suspected of inoculating into man such grave diseases as infantile paralysis and meningitis.

Certain insects, however, are responsible for dissemination of specific microbes, and only through specific insects are certain diseases contracted. For example, it is through the medium of the louse alone that the disastrous typhus fever attacks man. Likewise the fatal Rocky Mountain spotted fever of Montana can be contracted only through the bite of the tick.

In the war on, and subjugation of, the pathogenic microbes, the destruction of these carriers is as efficacious in the elimination of a disease as is the destruction of the germ itself. Two noteworthy diseases, malaria and yellow fever, which have profoundly affected the activities of man, are now being vanquished as a result of war against the carriers.

Malaria is due to an animal microörganism, discovered by Laveran in 1880, which enters the red blood cells and there saps out the function and vitality of these important cells. How these devitalizing protozoan organisms gained entrance into the blood stream was an important and perplexing problem. This was finally settled by Major Ross, of the English army, who demonstrated that a certain genus of mosquito—*Anopheles*—was responsible for injecting the microbes into man. This mosquito imbibes the protozoan from marshes or infected blood, and it then lives and multiplies in the intestines of the mosquito after which it is inoculated into man when the mosquito sucks its diet of blood.

To prove that the *Anopheles* is responsible for malaria, men

offered themselves as martyrs. The humanitarian and unselfish devotion of such men as Manson, Samborn, Low and Terzi, in living among the malaria infected swamps of Greece in order to prove the deadly rôle that the *Anopheles* play in the misfortunes of man, is worthy of all praise. Truly such men should have monuments erected to their memories in order to remind mankind of their sacrifices to the welfare of humanity.

The mosquito has been a very important factor in the affairs of man. Let us quote from Ronald Ross's paper on "Malaria in Greece."*

"In prehistoric times Greece was certainly peopled by successive waves of Aryan invaders from the north—probably a fair-haired people—who made it what it became, who conquered Persia and Egypt, and who created the sciences, arts and philosophies, which we are only developing further to-day. That race reached the climax of its development at the time of Pericles. Those great and beautiful valleys were thickly peopled by a civilization which in some ways has not been excelled. Everywhere there were cities, temples, oracles, arts, philosophies, and a population well trained in arms. Lake Kopais, now almost deserted, was surrounded by towns whose massive works remain to this day. Suddenly, however, a blight fell over all. Was it due to internecine conflict or to foreign conquest? Scarcely, for history shows that war burns and ravages but does not annihilate. Thebes was thrice destroyed, but thrice rebuilt. Or was it due to some cause entering furtively, and gradually sapping away the energies of the race by attacking the rural population, by slaying the new-born infant, by seizing the rising generation, and especially by killing out the fair-haired descendants of the original settlers, leaving behind chiefly the more immunized and darker children of their captives won by the sword from Asia and Africa? Could it (the malaria) not have been introduced into Greece about the time of Hippocrates by the numerous Asiatic and African slaves taken by the conquerors? Supposing, as is probable, that the *Anophelines* were already present, all that was required to light the conflagration was the entry of the infected persons. Once started, the disease would spread by internal intercourse from valley to valley, would smolder here and blaze there, and would, I think, gradually eat out the high strain of the northern blood.

"I can't imagine Lake Kopais, in its present highly malarious condition, to have been thickly peopled by a vigorous race, nor, on looking at those wonderful figured tombstones at Athens, can I imagine that the health and power people represented upon them could have ever passed through the anemic and splenomegalous (to coin a word) infancy caused by widespread malaria.

"The whole life of Greece must suffer from the weight which crushes its rural energies. Where the children suffer so much, how can the country create that fresh blood which keeps a nation young?"

* Macfie, The Romance of Medicine, pp. 160-162.

Quoting from Macfie: "The Turk and mosquito together have destroyed Greece, and perhaps the mosquito has been the most destructive. Little did the Greeks know that the blood of the slaves they imported swarmed with microbes that would devour there mighty civilization. Yet so it seems it was. Nemesis is a gnat."

Although the offending microbe of yellow fever has not been determined, yellow fever has been practically stamped out. Especially after the meritorious labors of Ross, it was suspected that some species of mosquito was responsible for the transmission of malaria. Search for the insect was initiated by Sternberg, Reid, Carroll, Lazear, and others of the American Army Medical Service in Cuba during the summer of 1900. Eleven men volunteered for the experiment. They permitted mosquitos which had previously fed on yellow-fever patients to bite them. Doctors Carroll and Lazear contracted the disease, and the latter died. Thus was the *Stegomyia* "caught with the goods."

After having demonstrated that this mosquito was responsible, Doctor Reid and associates began experiments to ascertain whether the disease could be propagated, as was the current belief, by clothing, bedding and other articles, from yellow-fever patients. Into a specially erected, nonventilated, dark building, contaminated clothes from the beds of yellow-fever patients were dumped. This bed clothing was saturated with the vomitus and excreta of the patients. Assuredly it required the great courage of brave and unselfish men to enter this odious, fetid, foul house of the dead. Yet that is exactly what the volunteers did, and they remained there several days under these most loathsome conditions. None contracted the disease, however, thus heroically demonstrating that yellow fever is not contagious by association, but depends solely upon the mosquito *Stegomyia* for its transmission.

The inhabitation of the luxurious tropics is now a matter of the eradication of this mosquito.

XVII. MICROBES AND NATIONS.

Already have we learned that microbes—these silent, invisible instruments of death—have played a great rôle in the affairs of man. Without doubt the hæmamœba of malaria and the tubercle bacillus have been two great factors in the rise and fall of nations. Microbes not only have destroyed nations, but

have builded them as well. Perhaps to the tubercle bacilli England owes her supremacy. Columbus discovered America, but the bacillus of tuberculosis conquered the northern half. The hæmamœba, however, on the other hand, defended the southern half against the Spanish and Portuguese invaders.

University of Kansas, Lawrence.

SOME EXPERIMENTS WITH BACILLUS COLI COMMUNIS (ESCHERICH).

FRANK U. G. AGRELIUS.

IN OUR WORK with water analysis we have frequently observed that the water of the hydrants, cisterns, and sometimes that of wells, will give positive results at a certain time, and after a few days it will be negative or nearly so. This led us to attempt an experiment to test the matter somewhat more under control, and to see whether *B. coli* would behave that way then.

We took two liters of tap water and placed it in an ordinary Erlenmyer flask and kept it in a dark, cool room of a temperature from 13.2 C. to perhaps 20.0 C. We placed in this water 1 cc. of a broth culture of *B. coli* recently isolated from sewage. After stirring the water in the flask well we inoculated a fermentation tube of medium size with 1 cc. of this water and placed it and a duplicate in a 40° oven. We started also duplicate tests of *B. coli* (1 loopful), and of tap water (1 cc.) at the same time, December 29, 1915.

The tap water proved free from *B. coli.* The *B. coli* from the broth direct gave 57 percent of gas. By January 8 the water gave entirely negative tests, and it gave these uniformly thereafter until the 11th, when we stopped the tests. We have represented the results graphically, where they can be seen more perfectly. (Fig. 1.)

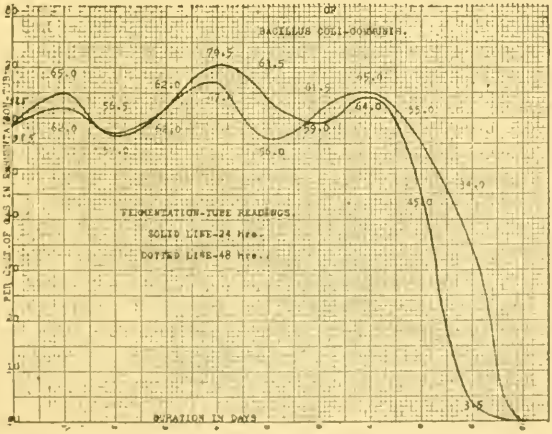

FIGURE 1.—Special test of *Bacillus Coli communis.*

From this we conclude that for some reason this organism is not likely to persist long in ordinary water unless more organic material is added to furnish it with food. Perhaps this would not keep it alive either. We have not had time to determine whether it could be again isolated and restored to its former power. We hope to continue the experiment longer.

WATER TESTS, KANSAS STATE NORMAL, EMPORIA, 1915.

We have charted (Figs. 2, 3) the results of the regular water tests made by us during the year 1915. These include 11 tests of well water, 35 of cisterns, and 117 of the city water; 163 in all. The chart does not give a very accurate

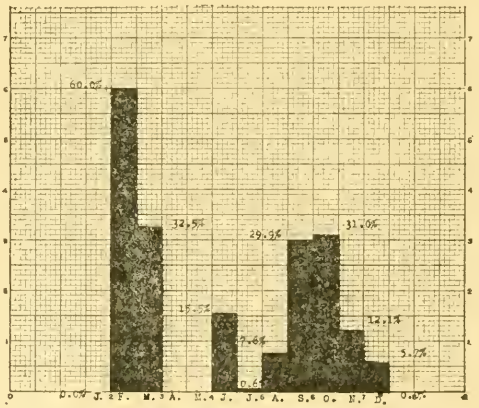

FIGURE 2.—Emporia city water. Monthly averages of fermentation—tube tests, 1915.

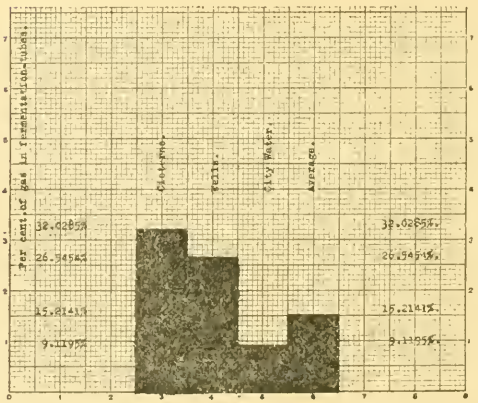

FIGURE 3.—Water tests, Kansas State Normal, Emporia, 1915.

story, but there is some indication of the real facts, especially for the last three months of the year when we began making regular daily tests, Sunday excepted. This is done for the sake of the school and the homes furnishing students, or offering board or lodging for them. It has been done freely, with the hope of serving the community as well as the school.

In the light of the fact that we are to have treated water soon, it will be more important to have data for comparison later. One thing that does not show is, that after fires in the city the water was much more likely to have *B. coli* present in it, or at least showing in the hydrant. Again, this has been an exceptionally wet year. The Neosho river—the source of our supply had floods or high water in it an unusually large proportion of the time. This accounts for the amount of gas showing in it. We have had but little typhoid fever. In my opinion it has been because of the freedom from this disease on the watershed, rather than because of the treatment which the water receives.

Kansas State Normal School, Emporia.

BOTANICAL NOTES.

Frank U. G. Agrelius.

1. SOME PECULIAR LICHENS COLLECTED AT OSWEGO, KAN., SEPTEMBER, 1915.

WHILE collecting plants near Oswego, Kan., on the 4th of September, 1915, we collected what seemed to us to be hybrid lichens. At least there seemed to be two distinct species, with intermediate forms grading into each other.

The one I judge to be *Cladonia Pyxidata* (L.) Fr., the brown-fruited lichen; and the other *Cladonia rangiferina* (L.) Hoffm., one of the "reindeer lichens."

The intermediate forms pass from the former to the latter by a gradual disappearance of the scales and lobes characteristic of *C. pyxidata*, and a gradual assumption of the upright, much-branched habit of the reindeer lichens.

Lichens are symbionts, consisting of various fungi associated with various algæ, and as these were growing more or less intimately, it is reasonable to suppose that the various elements of the two symbionts might be somewhat forced into an

unnatural combination of the four possible elements. There would thus result a somewhat intermediate form. This seems to be the case, as one may judge by ordinary observation of the specimens submitted.

2. EXPERIMENTS IN OSMOSIS OF LIQUIDS. (Fig. 4.)

We had often tried this experiment and had never had the tube long enough. Assisted by Mr. Clifford Hall, a student in the department, we tried to see how far the liquid would rise under the conditions of the experiment.

For a membrane we used the skin of an ordinary egg. The

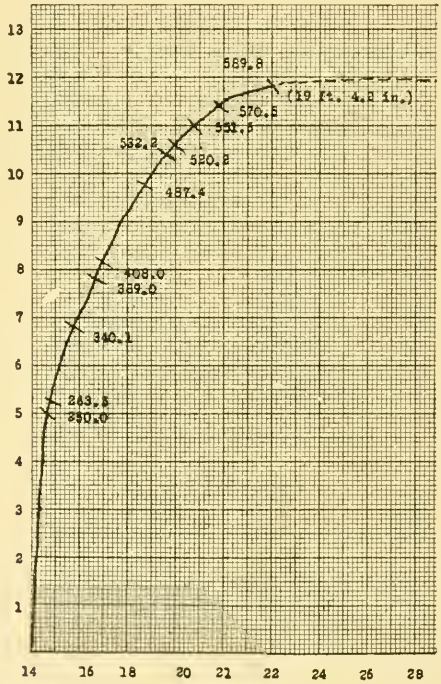

Figure 4. Osmosis test. 1 unit vertically = 5 cm. 1 cm. horizontally = 1 day.

shell was removed by immersion of the egg in 25 percent hydrochloric acid overnight. Care was taken to keep the egg covered by the acid by holding it under with a test-tube held in a clamp. The end of the egg thus treated was cut off with a razor, the contents removed, and the membrane washed in water. To contain the sorghum, a thistle tube with a short tube was used. The sorghum was full strength, and was the

material used to bring about osmosis. The cup of the thistle tube was filled with the syrup, the membrane slipped over it, and this supported by a piece of ordinary white cotton cloth. The cloth and the egg skin were then firmly tied with string. Connection was made to the rest of the tubing by means of rubber tubing. In order to have the proper height the experiment was set up in the hallway of the Science Building. The water used amounted to 1550 cc. As this became sufficiently colored to indicate the presence of syrup to a noticable degree, it was replaced by distilled water. The thistle tube with the membrane on it was immersed in the water 7.5 cm. This was on July 14, 1915.

The results in tabular form follow:

Date.	Hour.	Height of water in cm.
July 14, 1915.....	(?)	0.0
July 15, 1915.....	8:30 a. m.	250.0
July 15, 1915.....	10:00 a. m.	263.5
July 16, 1915.....	12:00 m.	340.1
July 17, 1915.....	9:00 a. m.	389.0
July 17, 1915.....	4:40 p. m.	408.0
July 19, 1915.....	10:00 a. m.	487.4
July 20, 1915.....	7:10 a. m.	520.2
July 20, 1915.....	6:00 p. m.	532.2
July 21, 1915.....	12:00 m.	551.6
July 22, 1915.....	12:05 p. m.	570.5
July 23, 1915.....	2:00 p. m.	582.7
July (?) 1915.....	(?)	589.8 (19 ft., 4.2 in.)

Our conclusion is that under these conditions the water will likely rise about 20 feet in the tube. It certainly is a striking experiment to show to pupils. This attracted much attention and helped to acquaint people with this fundamental principle in the economy of living things. We shall probably try it under different conditions.

3. THE RESTRICTED RANGE NOTED FOR *PARONYCHIA SESSILIFLORA* NUTT., IN KANSAS.

While doing some work for the State Biological Survey of the University of Kansas the writer noted what seemed to him a remarkable case of restricted environment. Work was begun that year (1911) on the 5th of July, in Logan county, at Oakley, on the Union Pacific. After working several weeks alone, we were joined by Mr. Orville Wilson, now of the botany department of the University of Cincinnati. The

work of the collection and study of plants and their environment was quite thorough in that county (Logan), and included some of Gove, Scott and Thomas counties. We then transferred to Sherman county, at a point about ten miles south of Goodland on the north fork of the Smoky Hill. Here we found fine conditions for a good and varied collection of plants. The topography is varied, as also the water conditions. We collected some fine hydrophytes, notwithstanding the severe drought of that summer. There are some rather pronounced breaks or buttes along the Smoky, and these gave us xerophytic conditions on their summits and points, and springs at their bases, with every gradation between.

On one of our excursions from camp we had separated for a short time, Mr. Wilson going to the head of a canyonlike depression, while I went down through it and towards the point of a bluff on the opposite side. This would give us all the conditions in that place and would be accomplished more satisfactorily. Reaching the opposite ridge ahead of Mr. Wilson, I decided to investigate the point of rock forming its limit and overlooking the valley. The arrangement is much like that of the pommel of a saddle, making the spot quite isolated. I here discovered a plant new to us. It formed a thick mat on the rocks, covering an area of perhaps twelve by fifteen feet. It was xerophytic in habit, as indeed it needed to be to survive such rigorous conditions. It would be exposed to the extremes of cold and heat in winter and summer, and to similar changes in moisture. It was prepared for this by a severely restricted amount of exposed surface. The leaves are needlelike and forbidding. The roots are well covered by the tufted upper parts and are woody. The soil that may be formed is held by the matted habit. The roots took advantage of the nooks and crannies in the rock to seek for moisture and further protect themselves. The whole plant was but a few inches high. It had well occupied the spot, however, and there were many individuals, all told. This proves that it found the conditions favorable for its growth.

We made the usual notes and collected specimens of the plant. Upon study we found it to be *Paronychia sessiliflora* Nutt., a member of the Illecebraceæ or knotwort family. Britton and Brown give its habitat as follows: "In dry soil, Saskatchewan to Montana, Nebraska, and Colorado."

The finding of a new plant was for us always an event of importance, and we always kept such in mind and always looked the more assiduously for it again. This one seemed especially peculiar to us, and so we kept it particularly in mind. We completed our survey there, visited the western and the northern parts of that county, and next moved to Cheyenne county. Here and in Rawlins county we found many places that we considered similar to the one described, and we searched carefully for our new friend, whitlow-wort, but completely in vain. That spot of earth or rock, twelve by fifteen feet in extent, seemed to be its limits within the region covered by the survey. A thorough study of Scott and Wichita counties, and a slight one of Greeley, failed to reveal a trace of this plant. We presume it to be doubtful whether it exists naturally in any other part of our state.

We judge that it has probably been carried to this spot by birds, this being a natural alighting place. However, Indians, or wild animals other than birds, using it also as a point of vantage, resting where they could see widely, and hence be safe from surprises by enemies, might possibly have inadvertently dropped the seeds here.

However this may be, the plant is there, and in what seems to us a very circumscribed area, considering the possibilities of the case.

4. NOTES ON THE UNUSUAL SEASONABLE ACTIVITIES OF CERTAIN PLANTS, 1915.

While on a trip to Oswego, Kan., we were surprised to note one of the wild onions in full bloom, and this on the 4th of September. This set us to observing, and as a result we have the following list to report. Unless otherwise stated, the plants were found in or near Emporia, Kan., and were in bloom at the date given. The month or season mentioned is the one in which flowering usually takes place. By comparison with the date first given in each case, one may see how far the plants are out of ordinary in this respect.

Sept. 4. Wild onion. *Allium mutabile* Michx. Oswego. April, June.
Sept. 5. Wild onion. *Allium mutabile* Michx. Near Clements, Kan.
Nov. 6. Cultivated Yellow Rose. *Rosa sulphurea* Ait. (?) Spring, Summer.

Nov. 7. Cultivated strawberry, in fruit and for sale. Evidently the ordinary kind, not the everbearing. *Fragaria chiloensis* Duchesne, var. *ananassa* (?). In Missouri as noted in the Kansas City *Star*.

Nov. 8. Ordinary cultivated strawberry. Flowers and immature, green fruit. Writer's garden, 1501 Rural street. May, June.

Sweet Pea. *Lathyrus odoratus* L. Summer.

Pear, *Pyrus communis* L. Spring.

Apple, *Pyrus malus* L. Spring.

Spiræa callosa-alba. (*Spiræa japonica* var. *callosa-alba* (?) .) Spring and Summer.

Spiræa van Houttei (?). Spring.

Shepherd's purse. (*Capsella bursa-pastoris* (L.) Medic.) Early spring.

Bird's foot violet. *Viola pedata* L. (In our garden.) April, May, and late summer and autumn.

Canna sp. Late summer and fall.

Cultivated larkspur, from this year's seed. *Delphinium consolida* L. (?). Summer and fall.

Red sage. *Salvia splendens* Sellow. Summer and fall.

Cosmos bipinnata Cav., from this year's seed. Summer and fall.

Dandelion. *Taraxacum officinale* Weber. April-September, and rarely autumn and winter. From this year's seed.

Sweet alyssum. *Alyssum maratimum* Lam. Summer.

Sow thistle. *Sonchus asper* (L.) Hill. Summer and autumn.

Nasturtium. *Tropæolum majus* L. Summer.

Radish. *Raphanus sativus* L. Late spring and early summer.

Tomato. *Lycopersicum esculentum* Mill. From this year's seed. Summer.

Cardinal raspberry. *Rubus* sp. June to August. Has green fruit.

Yellow sorrel. *Oxalis stricta* L. April-October.

Garden Pea. *Pisum sativum* L. Fruiting. Late spring and early summer.

Mignonette. *Reseda odorata* L. From this year's seed. Old ones are blooming again. Summer.

Pepper grass. *Lepidium virginicum* L. (?) May-November.

Erigeron canadensis L. In abundance. June, November.

Corn. *Zea mays* L. Self-sown; this year's seed. This was suckerlike. June-August.

Sultana. *Impatiens sultani* Hook. Reflowering after some cessation and killing of some by frost. Summer and fall.

Nov. 10. *Narcissus* sp. Early spring. (Reported by Myrtle C. Hunter.)

Nov. 11. Yellow sweet clover. *Mellilotus officinalis* (L.) Lam. Summer.

Erigeron ramosus (Walt.) B. S. P. May-November.

Mouse-ear chickenweed. *Cerastium brachypodum* (Engel.) Robinson. March-July.

Nov. 13. Wild strawberry. *Fragaria virginia* Duchesne. April-June. (Reported by Claire Agrelius.)
Wild violet. *Viola cucullata* Ait. April, May. (Reported by Kenneth Agrelius.)
Nov. 14. A heavy frost occurred on this date.
Nov. 16, and several days later. Bridal wreath. *Spiræa prunifolia* Sieb. and Zucc. June.
Nov. 19. Mustard. *Brassica nigra* (L.) Koch. (?). June to November. (Reported by Roy Morrison, a pupil.)
Nov. 24. Mayweed. *Anthemis cotula* L. June to November. (Collected by Morrison.)
Jan. 3, 1916. Dandelion in blossom. Many heads were scattering fruits. A few days previous to this the temperature was one degree below zero.

Several of these plants were in bloom at periods later than the date noted. One notable instance was the bird's foot violet. No exact date was recorded, and hence cannot be given.

Below the same plants are arranged in the order given in Gray's Manual, seventh edition. Common names are omitted.

Plant.	Date of observation.
Zea mays L.	Nov. 8, 1915
Allium mutabile Michx.	Sept. 4,5, 1915
Canna sp.	Nov. 8, 1915
Narcissus sp.	Nov. 10, 1915
Cerastium brachypodum (Engel.) Robinson	Nov. 11, 1915
Delphinium consolida L.	Nov. 8, 1915
Alyssum maratimum Lam.	Nov. 8, 1915
Lepidium virginicum L. (?)	Nov. 8, 1915
Capsella bursa-pastoris (L.) Medic.	Nov. 8, 1915
Raphanus sativus L.	Nov. 8, 1915
Brassica nigra (L.) Koch. (?)	Nov. 19, 1915
Reseda odorata L.	Nov. 8, 1915
Spiræa japonica L., var. *callosa-alba* (?)	Nov. 8, 1915
Spiræa trilobata L., var. *van Houttei* (?)	Nov. 8, 1915
Spiræa prunifolia Sieb. & Zucc.	Nov. 16, 1915
Pyrus communis L.	Nov. 8, 1915
Pyrus malus L.	Nov. 8, 1915
Fragaria virginiana Duchesne	Nov. 13, 1915
Fragaria chiloensis Duchesne, var. *ananassa* (?) (Fruit mature and sold)	Nov. 7, 1915
Fragaria chiloensis, etc. Flowers and green fruit	Nov. 8, 1915
Rubus sp. Has green fruit	Nov. 8, 1915
Rosa sulphurea Ait. (?)	Nov. 8, 1915
Mellilotus officinalis (L.) Lam.	Nov. 11, 1915
Lathyrus odoratus L.	Nov. 8, 1915
Pisum sativum L. Fruiting	Nov. 8, 1915

Plant.	Date of observation.
Oxalis stricta L.	Nov. 8, 1915
Tropæolum majus L.	Nov. 8, 1915
Impatiens sultani Hook	Nov. 8, 1915
Viola pedata L.	Nov. 8, 1915
Viola cucullata Ait.	Nov. 13, 1915
Salvia splendens Sellow	Nov. 8, 1915
Lycopersicum esculentum Mill	Nov. 8, 1915
Solanum nigrum L.	Nov. 8, 1915
Erigeron ramosus (Walt.) BSP.	Nov. 11, 1915
Erigeron canadensis L.	Nov. 8, 1915
Anthemis cotula L.	Nov. 24, 1915
Taraxacum officinale Weber	Jan. 3, 4, 1916
Sonchus asper (L.) Hill	Nov. 8, 1916

5. UNUSUAL GROWTHS OF TWIGS OF SEVERAL PLANTS IN THE SEASON OF 1916.

Along with the unusual flowering of certain plants we have noticed indication of abnormal twig development during the season just passed. We noticed this in the apple, apricot, peach and pear. The unusual appearance is in the fact that the twig which has all developed this season has the appearance of two or more intermediate zones of bud-scale markings. Thus the appearance of two or three years' growth results in the same season. Naturally, then, we cannot always depend upon external appearances in determining the age of a twig. It may be that more careful examination would solve the question, but a cursory one will not.

The presumption is that one or two regular, or seemingly regular, winter or resting buds were formed by the twig, and then growth was again resumed in the same growing season. This all occurred in these trees without any artificial influence so far as we know. There was no watering done except what nature did. Indeed, we lost several trees this year from drowning, we are inclined to believe, and hence we were not tempted to add any more water.

The proof that the part of the twig in question grew all this past season is in the fact that this same part had the clothing of leaves on it that only results from the elongation of a terminal bud. Then in this particular case we had pruned the trees this spring and the place of pruning is still plainly visible, or enough so to determine what part of the tree grew this year.

A question at once arises as to whether this unusual external appearance would also be accompanied by deceptive internal records in the so-called "rings of growth." It is a well-known fact that resumption of growth in the spring is accompanied by a zone of woody tissue, containing at least larger water-tubes and other elements of the xylem, showing more open construction, thinner walls, etc. We have examined cross sections of this material and can say rather positively that there is not as pronounced a difference between the various layers added during the season as that usually found in the regular rings of growth. In some parts of a section there are some fairly well marked rings, but in others there is little to distinguish one part from another. A section might well be termed characterless. This might be expected when one considers the long-continued wet weather and coolness. Still there was enough difference at times to bring about retardation or cessation of growth, and then its recurrence. We hope to be better able to judge as to the facts when we shall have been able to secure twigs of what may be a more nearly normal season.

One peculiarity of the results this season is that some twigs on a tree show the above-mentioned marks of cessation and renewal of growth, while others do not.

In connection with the subject we wish to add that, in our opinion, a growing season with the usual spring and summer attributes, followed by a wet fall with renewal of growth, is more likely to disturb the annual markings than is one like the past season.

We conclude this, however, that outward appearances may be definitely deceptive as to showing the age of a twig.

6. DATA CONCERNING THE DISSEMINATION OF WHEAT RUST (*PUCCINIA GRAMINIS* PERS.)

Puccinia graminis Pers. in its complete development has five kinds of spores, as follows: spermatia, æcidiospores, uredospores, teleutospores, basidiospores. This last kind is produced by the teleutospores in the spring. These infect the young leaves of the barberry. The work of the spermatia is not known. These and the æcidiospores are found on the barberry. The latter infect the wheat. The fungus in the wheat at first gives rise to uredospores, which infect more wheat and thus spread the rust. Later the same mycelium produces the

teleutospores, or the black rust. These carry the fungus through the winter.

It will be seen that there are two hosts. It follows that if one host, or if any one stage, excepting the spermatia, be disposed of, then the rust will be stopped. It happens that in Kansas there is a negligible quantity of barberry, and yet we have much rust. It is true that there are other wheat rusts besides *Puccinia graminis*, but we have much that is apparently this species. Some other explanation must be had.

It may help some in understanding the problem to state that presumably only the æcidiospores and the uredospores are capable of infecting the wheat. Æcidiospores are probably only on the barberry, and we do not have the barberry. Uredospores are not supposed to withstand the winter, but we still have the rust. What is the answer to these seemingly contradictory statements? We shall endeavor to sum up the various theories, and perhaps add some original suggestions or facts having some bearing on the subject. It is an important one, as a loss estimated at one hundred million dollars annually in the world is said to occur from this parasite.

Strasburger[1] thinks that the fungus persists through the winter in the winter wheats. This would have to be infected in the fall, presumably from volunteer wheat, and this in turn from uredospores still retaining their vitality from the harvested wheat. Coulter[2] is authority for the statement that uredospores have been known to have lived through the winter and infected the wheat in the spring. He also states that teleutospores have been known to produce basidiospores capable of infecting very young wheat plants. Whether these could infect winter wheat plants started the fall before is an open question. Possibly there might be some wheat lying ungerminated in the soil, and that this could furnish the needed young plants. The teleutospores do not germinate until in the spring, it will be remembered.

We have often suggested to our students that there is some probability that the fungus is conveyed to, or is at least found in, the related perennial grasses near the wheat; that it there persists through the winter and again produces uredospores capable of infecting the related wheat. This suggestion is

1. Strasburger, Textbook of Botany, p. 407.
2. Coulter. Textbook of Botany, vol. 1, p. 85.

original with us, but we cannot claim priority. The objection brought forward by some writers is that there are physiological races existing in this fungus that are each confined to a rather narrow choice of hosts. Duggar states that in the race on which wheat is included also includes *Hordeum*, *Agropyrum* and *Elymus*. All of these are represented in our flora, the second and third by perennials; for example, *Elymus canadensis* L, wild rye. The same author classes the oat in a different race from that of the wheat. Considering the fact that the fungus has leaped over its main characteristics sufficiently to omit one of its fundamental, well-established characters, we are loath to believe that the form on the oat is not capable of infecting the wheat. We have long ago learned, however, that opinions do not affect facts!

In our opinion, while other theories may account for the wintering of wheat rust here in our section, this fungus persists and succeeds without the æcidium stage, because of the presence of many native and mostly perennial grasses. Some of our reasons are that these grasses are to be found quite intimately associated with the cultivated grains. Secondly, that we have found them retaining their green color and still evidently infected with a fungus presumably alive within the tissues of the grass. We collected some of this on the third of this month (January), following zero weather. On the same day we collected *Dactylis glomerata* L., orchard grass, with uredospores on the green leaves. These did not appear to be true red rust of wheat, however, although they appear much like some found on wheat. We have collected and here present a specimen of what is probably *Panicum virgatum* L., with an abundance of red and black rust on it. Upon examining these with the microscope the spores are found to be typical *Puccinia graminis*. They may be of such a race that they cannot infect wheat, but their external characteristics do not bear out such a conclusion. *Panicum virgatum* L., is a perennial grass very common in Kansas. It is often found very close to grain fields.

Our contention must still be considered theoretical, however, as we have not demonstrated it. Nevertheless we have much faith in the correctness of it and we shall endeavor to search for facts having a bearing on it.

Kansas State Normal School, Emporia.

BOTANICAL NOTES, 1917.

Frank U. G. Agrelius.

POTATO "SEED."

DURING the last year or so there has been some interest shown in the matter of the fruiting of the ordinary "Irish" potato, *Solanum tuberosum* L. It seems, according to the discussions, as quoted in the *Literary Digest*, that the production of fruit by this plant is becoming quite uncommon. This agrees with the writer's observations that such fruits seemingly seldom, or almost never, are produced in our locality. This is a matter of much importance because of its connection with the production of new varieties. The failure of the ovary to mature renders impossible any results along the line of hybridation.

It is the recollection of the author that he observed matured seed balls on potato plants quite commonly during his boyhood in Wisconsin, but this is a matter of some doubt when not properly noted. However, when we were digging the potatoes in our own garden this past summer, as stated elsewhere in these notes, we observed a fairly well-developed fruit on one plant. It was not well matured, though, and as the part of the plant just below the ball was shriveling, it is quite probable that it would never have ripened seed. It does show that in all probbility, however, the cultivated potato is still able to mature its fruit occasionally and in this latitude.

MORE EVIDENCE ON THE QUESTION, WHAT ARE POTATO TUBERS MORPHOLOGICALLY?

The past season was decidedly wet during much of the growing period of the potato, *Solanum tuberosum* L. We harvested ours in July after the dry period was well advanced. The tops were largely still alive, but they showed considerable evidence of the peculiar phenomenon known as "little potatoes," due to a fungus, as later noted. The point in question here is that these little potatoes are quite evidently buds. They are produced on the stem and in the axils of the leaves, where buds regularly appear. Furthermore, they had "eyes," gradually changing to evident buds and ordinary leaves farther up toward the top of the tuber. Buds are commonly undeveloped

or more or less modified branches, and here is added evidence that potato tubers are but modified stems—in reality buds—for the storage of food for the plant and as a means of reproducing the plant vegetatively. It has long been known that "potatoes" are as explained above, but this is not always evident to those not familiar with botany.

RHIZOCTONIA ON POTATOES IN LYON COUNTY, KANSAS, 1916.

As noted previously, potatoes in the author's garden during the growing season of 1916 were subjected to very damp conditions for much of their development. From appearances we judged that one response was a very noticeable increáse in the seeming lenticels often found on potato tubers. These were large and numerous and appeared an attempt on the part of the plant to obtain a sufficient quantity of air for its underground parts. The tubers themselves did not seem to be seriously damaged by this condition and there was a fair crop. The potatoes were of the usual quality as food, and they kept until well into December, when all had been used. To us the evidence of the disease was most apparent in the numerous little potato tubers produced in the leaf axils. This condition is known as "little potatoes," and is a peculiar response to an abnormal condition. The peculiarity did not confine itself to the parts above ground, however, but little potatoes occasionally were produced as direct outgrowths from the part of a tuber planted in the spring. A rather unusual circumstance in this case is the fact that the cuttings quite often passed through the entire season of growth with but little if any apparent change. This, moreover, was the case when the part had given rise to the usual plant.

So far as we can remember, this is the first time we have noted *Rhizoctonia* (*Corticium vagum* var *solani* Burt.) in our garden. We shall be interested to note whether it again appears.

NOTES ON THE UNUSUAL FLOWERING OF CERTAIN PLANTS, 1916.

Continuing the practice begun in 1915, we report the following instances of the untimely blossoming of plants. All of these were in or near Emporia, Kan.

Syringa vulgaris Linn. In full bloom September 26, 1916. McNeely home.

Viola cucullata Ait. September 30, 1916; Soden's grove.

Viola cucullata Ait. October 19, 1916; 1501 Rural street (writer's home).

Viola Pedata L. October 19, 1916; 1501 Rural street (writer's home).

Viburnum opulus sterilis. November 11, 1916; Twelth ave. shrubbery.

Capsella bursa-pastoriso (L.) Medic. November 11, 1916. 1501 Rural street.

Kansas State Normal School, Emporia.

THE ALGÆ OF KANSAS RESERVOIRS.

(Preliminary Paper.)

James B. McNaught.

THIS investigation was undertaken with a twofold purpose. First, it is intended that the data when available in completed form shall serve as an aid to the sanitary engineer by explaining the harmful effects of heavy growths of microorganisms in the city water reservoirs, and by describing the organisms causing trouble and the best methods for their eradication. Second, it is the first survey of the algæ of Kansas by the University. This survey was planned several years ago by the department of botany and the Water Survey, but was not begun until the summer of 1915, when the author made his first complete survey of the reservoirs of the surface water supplies in Kansas.

The study of the microörganisms in water has gone hand in hand with the development of the compound microscope, dating back to the seventeenth century. In 1850 Doctor Hassall, of London, first called attention to the fact that these organisms have a sanitary significance in drinking water. In 1887 the first systematic examination of the water supplies in this country was made by the Massachusetts State Board of Health. Since that time survey work upon the algæ of the water supplies has been done in many states preliminary to the practical work of the sanitary engineer.

The first data upon the algæ found in Kansas was published in September, 1884, in a bulletin of the Washburn laboratory of natural history. This was a list of twelve species, identified by the Rev. Francis Wolle, of Bethlehem, Pa., and was incorporated in the Biological Survey which Francis W. Cragin, professor of natural history, was conducting at Washburn College. In January, 1885, July, 1886, and January, 1889, the second, third and last lists appeared. Altogether there were listed fifty-three species. These publications contain all of the data which is available in our state upon our local algæ.

In our neighboring states considerable work on the listing of the algæ has been published. Nebraska has issued, through its Botanical Survey, five bulletins under the directions of Professors Bessey, Pound, Clements and Webber. In Iowa,

R. E. Buchanan published "Notes of the Algæ of Iowa." Colorado has two reports by G. H. Wailes and W. W. Robbins. Missouri has a survey bulletin prepared by Miss Ada Hayden on the "Algæ Flora of the Missouri Botanical Garden of St. Louis" and a "Preliminary Check List," prepared by the Englemann Botanical Club, containing about one hundred and thirty-five species. Oklahoma has published no lists of their algæ flora.

The work of G. N. Calkins and G. C. Whipple and others have shown the marked effect that heavy growths of certain genera of algæ have upon the usability of drinking water. In the first place, the water often is given a very disagreeable odor. These odors can be classified into natural odors and those of decomposition. The former are often described as aromatic odors, especially for those of the Diatomaceæ, grassy odors for the Myxophyceæ, and fishy odors for the Chlorophyceæ. The odors of decomposition are usually more offensive than the natural odors. The Myxophyceæ, when decaying, give a "pig-pen" odor, *Beggiatoa* gives the odor of hydrogen sulphide or "rotten eggs," while to some of the other genera the odor of garlic, onions, etc., is ascribed. Water having these strong odors also has a very disagreeable taste. The decaying vegetation often gives the water in addition a yellowish-brown color, making it unattractive and in some cases unfit for use, even for washing purposes. Besides this trouble with odors, tastes and color, the algal forms do much damage in clogging the filters and decreasing the length of run quite materially. The diatoms and other unicellular forms cause the most trouble because of the dense mat which they are able to form over the top of the sand. The filamentous algæ, which grow erect upon the sand, do not thus clog the filter, but, on the contrary, they prevent clogging to some extent by their waving threads. However, when these forms decay they too settle to the bottom and block the filter. Another danger to the filter is due to the release of gas by these plant forms, which at times is sufficient to cause great masses of the mat to rise, thus exposing the sand so that the water filters through it much more rapidly than it should to give efficient results in the tap water.

The elimination of the algæ from the filters can be accomplished by covering them, since these plants can live only in the light. The eradication of the algæ from the reservoirs

was a problem until Moore and Kellerman, in 1905, issued a report stating their successful experiments in the removal of algæ by the use of copper sulphate. This treatment has been in practice ever since, and has proven to be entirely satisfactory. The method of application as given by the above-mentioned workers is as follows: "Place the required number of pounds of copper sulphate in a coarse bag, gunny sack or some equally loose mesh, and attaching this to the stern of a rowboat near the surface of the water, row slowly back and forth over the reservoir, on each trip keeping the boat within ten to twenty feet of the previous path. In this manner about one hundred pounds of copper sulphate can be distributed in one hour." Care should always be exercised in dosing not to allow too great a concentration of the solution to be made in one place, because of the danger to fish swimming through that portion. The writer found that it is always better to make the treatment on a windy day, so that the currents in the water may more readily distribute the chemical.

It is of great importance to determine the exact proportion of copper sulphate to the volume of water to be dosed, since too small a proportion will not affect the algæ and too great involves unnecessary expense, and may kill off the fish. The quantity of water to be treated in a large impounding reservoir may be estimated by multiplying the number of acres of water surface by the average depth (taken as about ⅓ of the maximum depth) and dividing this product by 3. This gives approximately the number of million gallons of water in the reservoir.

Since some genera of algæ require more copper sulphate than others, it is quite essential that the genus of the algæ causing the trouble be determined by microscopical examination. The algæ which appeared in the reservoirs in the two years' survey, and which, therefore, are the most common in Kansas, may be identified by the descriptions in the key and drawings included in the final report.

After the quantity of water to be treated and the causative organisms have been determined, the dosage of $CuSO_4$ may be found by referring to Table II in the final report, a portion of which is given below.

Quantity of Copper Sulphate required to kill various forms of odor-producing organisms.

Expressed in pounds per million gallons of water.

Anabæna	0.75	Draparnaldia	2.5
Asterionella	0.80	Euglena	8.3
Cladophora	8.30	Fragilaria	2.1
Clathrocystis	0.8	Navicula	0.6
Conferva	3.3 to 16.0	Oscillatoria	0.8 to 3.3
Chlamydomonas	4.2	Spirogyra	0.4 to 2.5
Dinobryon	2.5	Ulothrix	1.7

Immediately following the killing off of the algæ by $CuSO_4$ the odor often increases for a few days because of disintegration, but this soon passes away. Another effect of the disintegration of the algæ is the perceptible increase in the bacterial count. This can be kept down by the proper use of hypochlorite.

Aëration also has a marked effect in the decrease of the algæ, by liberating the carbon dioxide gas which is essential to these plants for the manufacture of their food. Then, too, the odors of the algæ are liberated by this treatment. Many of the superintendents of the southern part of Kansas use the aërating system to free the water of the sulphur odor. A few workers have reported a ready removal of certain kinds of algæ from drinking water by direct oxidation with ozone, but from a practical point of view this method has never been developed.

We have in Kansas forty-three surface water supplies whose water is analyzed at the water and sewage laboratory of the State Board of Health at Lawrence once a week. This made it an easy matter for the writter to obtain samples of "moss" and algæ from the reservoirs at any time. Collections were made in the summer and winter of 1915 and the spring, summer and winter of 1916. This checking of each reservoir five times should bring out any changes due to differences in the seasons and give a more complete record on the flora of each reservoir.

The bottles used in collecting the algæ were large-mouthed, glass-stoppered, 100 cc. bottles, usually filled about one-half full of a 2 percent solution of formaline. Most of the analyses were made from preserved material. However, one complete analysis was made from each town on the living material, which was shipped into the laboratory on ice, and allowed to grow in aquaria.

In most cases the algæ were present in sufficient quantities to examine direct from the samples. In those cases in which small masses of the algæ could not be found in the basin or reservoir a liter of water from the basin was taken and the microörganisms present concentrated by the Sedgwick-Rafter filter method. This method of determining the actual number of microörganisms per cubic centimeter of water is especially valuable in recording the reduction of organisms during the copper-sulphate treatment. Most of the species found by this method were diatoms and other unicellular algæ.

At times samples of living algæ came into the laboratory in a vegetative condition and the species could not be accurately determined without the fruiting stage. This was especially true of the Conjugatæ. For such forms Klebs' method was used to induce fruiting. According to this method, such forms as *Spirogyra*, in a vegetative state, were placed in an aquarium of about 2 percent Knop's solution and left to grow for a few days. When a vigorous growth was shown the algæ were transplanted to a jar of distilled water in the sunlight. In most cases these conditions caused conjugation, aiding greatly in classification to species.

The key before mentioned contains an accurate and concise description of the 110 species of algæ found throughout the five seasons covered by this survey, and a brief statement concerning the locality of each. There are thirty-eight figures in this report, drawn by the aid of the camera lucida from the material examined, which will greatly aid the student of microscopy in his identification and classification work.

Below are listed the genera of the algæ found throughout this survey, and the number of times each was found:

Myxophyceæ:	
Anabaena	4
Clathrocystis	8
Gleocapsa	1
Hypheothrix	1
Lyngbya	42
Merismopedium	6
Microcoleus	2
Nostoc	2
Oscillatoria	91
Phormidium	2
Spirulina	8
Total	167
Flagellata:	
Dinobryon	1
Euglena	5
Total	6
Heterokontæ:	
Conferva	15
Ophiocytium	2
Total	17
Chlorophyceæ:	
Botryococcus	1
Characium	2
Chalamydomonas	8

Chlorophyceæ:	
Cladophora	7
Closterium	4
Coelastrum	3
Cosmarium	11
Dictyosphaerium	5
Draparnaldia	1
Microspora	4
Microthamium	1
Mougeotia	6
Oedogonium	6
Pandorina	8
Pediastrum	5
Raphidium	17
Scenedesmus	10
Spirogyra	7
Stigeoclonium	3
Tetraspora	3
Haematococcus	1
Ulothrix	1
Zygnema	1
Total	115

Bacillarieæ:	
Amphora	10
Cymbella	23
Cocconeis	1
Encyonema	1
Fragillaria	4
Gomphonema	7
Melosira	3
Navicula	85
Nitzschia	8
Pleurosigma	11
Stauroneis	1
Surirella	3
Synedra	25
Total	182
Grand total	486

Out of the many cases handled by the workers in the water laboratory several interesting ones, showing the value of the copper method of removing algæ from the reservoirs in Kansas, will be briefly mentioned below.

In June, 1916, the water at Horton, Kan., was in "bad" condition, according to Superintendent W. W. Wood. The author made a trip to Horton and found the water had a very disagreeable odor and a dark reddish-brown color. The reservoir was found to be covered with a decaying mat of *Cladophora, Spirogyra, Zygnema, Mougeotia, Anabæna, Closterium, Euglena* and *Characium.* The odor from the reservoir was due to these decaying forms, likewise the color. The settling basin showed a count of sixty-eight organisms per cubic centimeter of water, forty-nine of which were *Anabæna.* The basin, with a capacity of 600,000 gallons of water, was treated with two and one-half pounds of $CuSO_4$ and allowed to stand for twenty-four hours. The supply was changed from the infested reservoir to the creek, whose overflow supplies the reservoir and whose waters at that time were comparatively free from algæ. In forty-eight hours all odors and color had disappeared.

In the fall of 1916 the Olathe water system was infested with extremely heavy growths of *Conferva.* Much of the dense entaglement was raked out upon the banks and the waters were treated at the rate of six pounds of $CuSO_4$ to a million gallons of water. The water was usable within three days.

Russell, whose impounding reservoir has a capacity of 39,000,000 gallons, was greatly troubled in September, 1916, with heavy growths of *Anabæna, Coferva* and *Cladophora.* The lowering waters had left a carpet of decaying algæ about the edge. The reservoir was treated with 50 pounds of the copper salt, and 100 more pounds were sprayed about the banks. No further trouble was reported.

In March, 1917, Burlington reported a very "bad taste" to the city water, and extremely offensive odors rising especially from the filter beds. Analyses showed the filters to be covered with numerous *Synedra, Navicula, Chlamydomonas* and *Clathrocystis.* The filters were washed, and about a foot of water, to which one pound of $CuSO_4$ had been added, was left standing in each. The basins were treated with eight pounds to the million gallons. The filters, after standing for eight hours, were drained into the sewer, and the water now let in from the basin and filtered was in good condition.

Occasionally difficulty which seems to be due to the algæ may be caused by the growth of small animals. A few cases in our state where water from the basins and filters has given off very foul odors have been traced to this cause. Early in May, 1917, Lyndon reported a very offensive fishy odor coming from their settling basin and filter. The walls were covered with a brownish-gray growth much resembling masses of roots. A sample of this material analyzed in the laboratory proved to be a *Polyzoa,* minute animals forming mosslike clusters. These small animals when in a state of decomposition give off an odor much the same as comes from a stagnant fish pond. The treatment advised was purely a mechanical one. The walls were scraped and the filters carefully cleaned. This seemed quickly to remove all the difficulty as to odors. In January, 1917, Kansas City complained of the heavy growths and bad fishy odors in their basins. The infesting form was found to be a *Polyzoan.* In February, 1917, great quantities of *Vorticella* were found to be the chief trouble causers at the State Hospital at Osawatomie. This small protozoan was successfully eradicated with copper sulfate.

SUMMARY.

Although there were but 13 genera of diatoms classified, they appeared 182 times, while the 23 genera of Chlorophyceæ, of which there were 55 species, were found only 114 times.

Thirty-six species of Myxophyceæ, falling under 11 genera, were found 167 times. There were 4 species of Heterokontæ and 2 Flagellata. The grand total indicates that the 51 genera of algæ appeared 486 times throughout the survey. Fourteen species of *Oscillatoria* were classified. This genus was found 91 times, and is the most common algal form prevalent in our reservoirs. The diatoms were always present, *Navicula* being found 85 times. It is of interest to note that although the specific genera varied from season to season, the number of genera remained quite constant.

The algæ of our state which have been found to be the most active in causing bad tastes, odors or colors in our drinking water are *Anabæna, Confervæ, Oscillatoria, Spirogyra, Cladophora, Clathrocystis, Synedra* and *Navicula.* Animals of the *Polyozoan* and *Protozoan* groups have also been found to cause these difficulties.

The collections of algæ during the five seasons brought out no changes due to the differences in the seasons. To determine whether this is due to the absence of seasonal influence on the flora or to the artificial conditions of the reservoirs requres data from a longer period of time than is covered by this paper.

The copper sulphate treatment for algal trouble has been very successful in Kansas.

Water and Sewage Laboratory,
State Board of Health, Lawrence.

SOME FACTORS IN THE WINTERKILLING OF GRAIN CROPS.

S. C. Salmon.

MORE than 16 percent of the wheat area of Kansas is abandoned each year, *i. e.*, not harvested. There are various causes, such as Hessian fly, green bugs, late seeding, etc.; but probably more than half, or nearly 10 percent of the total damage, is due to winterkilling.

The Experiment Station at Manhattan has been investigating the causes and possible means for preventing loss from winterkilling for about four years. Many lines of attack have been followed, but the results of two only can be given, one of which promises results of practical importance and the other of perhaps less immediate practical value, but of greater scientific interest.

SEEDING IN FURROWS.

One result of these studies is a new method of seeding, which, if generally used, apparently would prevent much of the injury that now occurs and permit the growing of winter grains farther north than is now possible. This new method consists in seeding the grain in furrows somewhat like those made by a corn lister, but much smaller and closer together. Sown in this way the grain is protected from wind by the ridges and from the effects of low temperature by the snow which lodges in the furrows. It is injured less by heaving of the soil by alternate thawing and freezing, and is better able to survive drouth because of the roots being deeper in the soil. In dry areas there is less damage from blowing of the soil and there is more certainty of the grain being placed in contact with moist soil. Since it is often difficult to get grain started in the fall in dry areas, this is likely to prove important.

Our data show very decided protection from seeding in this way. For example, winter oats sown in furrows in 1914 survived 86.5 percent, as compared with 7.5 percent when sowed in the ordinary way. Corresponding figures in 1915 were 44.9 percent and 33.3 percent; and for winter barley in 1915, 57.6 percent and 30 percent, and in 1916, 87 percent and zero. Experiments conducted at the Hays Experiment Station in

western Kansas show differences of from ten to forty percent in favor of the grain sown in furrows.

YIELD.

It has also been shown that the yield of grain sown in furrows is as high, and sometimes higher, than when sown in the ordinary way, even when no winter injury occurs.

The substitution of the grain drill for the old methods of seeding broadcast has no doubt reduced the damage from winterkilling very materially, and there is little doubt that the time will come when the drills now in use will give way to other types which make a larger furrow and leave more prominent ridges for the protection of the grain.

KIND OF SOIL AND MOISTURE CONTENT.

A study of relation of kind of soil and moisture content of the soil to temperature and winterkilling has proved a very complicated and interesting problem. Who can tell, for example, which is colder during the winter—a dry soil or a wet soil, a clay soil or a sandy soil. If there is a difference, on what does it depend? The question is not only interesting, it is important, since the winter survival and spring condition of important crops like winter wheat, alfalfa, clover, etc., depend on the temperature to which they are subjected.

The problem has been studied two winters by recording the temperature one, three and six inches deep of three plots of clay, three of silt loam, and two of sand, each containing different quantities of water. Twenty-four electric thermometers were used to record the temperatures. Winter wheat, winter oats and winter barley were grown on each plot to determine the effect on survival.

The relation was found to be very complex, the net result depending not only on the single factors studied, but also on the degree and duration of cold weather, whether the soil was frozen, and upon the rate of change of air temperatures.

To be brief, two seasons' results indicate that a wet clay or loam is warmer than a dry soil of the same kind (*i. e.*, has the highest daily minimum temperatures) as long as the ground is not frozen, due to the specific heat and the latent heat of fusion of the water contained in the soil. When the soil became frozen, however, directly opposite results were secured. This reversal was apparently due to the difference in specific

heat and thermal conductivity of ice and water. When water freezes the specific heat is reduced approximately one-half, while the thermal conductivity is increased more than three times. As a result the difference in apparent specific heat of a wet and a dry soil is much less when they are frozen than when they are unfrozen, while the difference in thermal conductivity is greatly increased. The increase of the latter appears to be sufficient to overbalance the difference in specific heat, permitting the temperature fluctuations of the air to be more quickly recorded in the soil.

The survival of the plants followed very closely the daily minimum temperatures. The highest percentage of survival was obtained on the wet plots in one season and on the dry plots another season. In the first case the soil was seldom frozen during the winter, while in the latter it was frozen most of the time.

The relation of moisture to temperature and winterkilling in the sand plots was contrary to its effects on clay or silt loam when the soil was frozen, but corresponded qualitatively with the other types when they were not frozen. In other words, the temperature of the dry sand was lower and the survival less than for the wet sand, regardless of whether the soil was frozen. This was probably due to sand being a better conductor of heat than other types, and hence the addition of water has less effect on the thermal conductivity. Also sand has a low water capacity, and consequently less change in the apparent specific heat takes place on freezing.

The results may be taken to indicate that winter annuals are more likely to suffer injury on wet soils than on dry ones, except for very easily injured plants which may be killed without the soil being frozen much of the time; and more on sandy soils than those of heaviest type, except when due to heaving of the soil.

Agricultural Experiment Station, Manhattan.

THE CULTIVATION OF MEDICINAL PLANTS IN THE UNITED STATES.

L. E. Sayre.

THE purpose of this paper is to call attention to the importance of agitating or keeping alive the question of growing medicinal plants in the United States. It is not the first time the writer has referred to this subject. Indeed, he has not only presented papers to the Academy, but for a number of years has written numerous articles urging the value of medicinal plant growing. Other states have taken up the subject seriously, but Kansas, almost the first to agitate the question, has done practically nothing to further the project. During the summer of 1915 the writer visited a number of states in the East and South to study the development of the industry, and his report was published in the *Western Drug Record*, November, 1915, where he referred to the cultivation of cannabis, hyoscyamus, belladonna, stramonium, digitalis, hydrastis, ginseng and other plants which practically demonstrated what may be accomplished. If our markets could have been supplied at home by such medical plant products, cultivated in this country, as, for example, colchicum (seed and root) and belladonna, we should not have to be paying, as we now do, the exhorbitant prices for them.

Belladonna root could be bought before the war for 40 cents per pound; now it is quoted at $6.50 per pound. Colchicum root, which brought about 35 cents per pound, is now quoted at $2.15 per pound. Colchicum seed, formerly about 35 cents per pound, is now bringing $2.40 per pound. This showing of rise in prices extends along the whole line of medicinal plants that might have been cultivated in this country in sufficient quantity to supply our markets.

Incidentally I may mention in passing that I have inspected one little garden of one-half acre of golden seal, or hydrastis, which is found on the banks of the Kalamazoo river, in Michigan. The products from this little covered garden brings to the gardener about $2,000 a year. Hydrastis is now selling in the neighborhood of five dollars a pound.

I could prolong this article to much greater length to prove the position that I have taken, that it would be a profitable

thing to cultivate the raising of our own medicinal plants in this country, but I shall not do more than call attention to the correspondence I have had with Mr. W. W. Stockberger, plant physiologist of the Bureau of Plant Industry, Washington, D. C., in which a discussion was carried on with regard to the establishment of a medicinal plant garden in connection with the school of pharmancy of the University of Kansas. I desire to quote from his letter in full to show the position this eminent authority takes with regard to the matter:

"The establishment and proper support of a medicinal plant garden as an adjunct to the college of pharmacy of your University should be of direct and practical benefit (*a*) to the students, (*b*) to the University, (*c*) to the people of the state. The students should profit largely from such an enterprise through the fact that they are brought into direct contact with medicinal plants in their living state, and learn at first hand the processes through which the fresh plant material must pass before it becomes the finished drug. Thus they will gain a working basis for their ideas regarding the necessity for the high standard of purity in crude drugs, as well as with respect to the opportunities for sophistication or impairment of quality through faulty methods of preparation and handling. Their interest and appreciation of materia medica will receive a great stimulus through their contact in an objective way with crude drugs during their preparation. Very important to the students also will be the grounding in the economics of the crude-drug trade which they will receive through the proper course of instruction which can be given in connection with the garden. The student who makes a careful record of the expenditure of labor (preferably his own) necessary to produce a given quantity of drug, and then, after marketing the same, deducts from his return a fair allowance for his work, will not be likely to become infected with the erroneous ideas now only too prevalent concerning the enormous profits to be derived from the commercial production of medicinal plants.

"To the University a medicinal plant garden is an invaluable aid and resource in the teaching of materia medica, pharmacognosy, botany and forestry. The medicinal plant garden will furnish much of the living material necessary for the first year's work in botany, and in the pharmacy school a double purpose will be served by using medicinal plants as working materials in teaching morphology and general plant histology. A medicinal garden also offers the student the means for pursuing the study of the production of the actual drugs in the field and practice in their collection and preparation. The supply of living plants which can be obtained from the garden will enormously increase the facilities for research work by the students of pharmacy. Most of the specifications regarding time and method of collecting, curing and preserving crude drugs are based on tradition and not on scientific experiment, and the determination of the relative value of our present requirements with respect to the preparation of drugs offers an almost limitless field of

research. In another direction, also, the study of the variation of the active principle among different species of a genus, or even among different individuals of the same species, affords great possibilities. The work on belladonna now being conducted by Mr. Sievers, of this office, is an illustration of this type of research, opportunities for which are practically without number, and many of which may be evident to your students through their medicinal plant garden. By this means not only will the effectiveness of the teaching be increased, but the interest and appreciation of students in this line of work will be aroused and held, and both of these factors are quite in harmony with the higher interests of the University. The institution will also gain credit from a consideration of ten points mentioned in the following paragraph:

"The establishment of a medicinal plant garden in connection with the college of pharmacy of your University is of direct value to the people of your state in many ways, a few of which may be briefly set forth:

"It will furnish information regarding the medicinal plants which are adapted for cultivation in Kansas, and thus provide a body of information invaluable as a guide to the agricultural population of the state. Such information will be of especial value in the immediate future, owing to the recognized necessity for wider diversification of the agriculture of this region.

"This garden, properly directed, will point the way to new agricultural industries which, though relatively small as compared with staple crops, yet contribute to a diversified agriculture, and afford opportunities for an individual here and there to add to his income or better utilize the agricultural facilities which he already possesses.

"By more widely diffusing knowledge respecting medicinal plants, this garden should lead to a fuller utilization of natural resources of the state, and should be the means not only of training the students who are to be pharmacists along these lines, but also of inculcating a wider interest in these resources and the dissemination of knowledge regarding them and their inherent possibilities.

"If the garden is conducted on a sufficiently large scale it will furnish data on the production of drug plants which when properly prepared and disseminated will safeguard the people of the state from loss through ill-considered ventures in drug-plant cultivation. This country is full of talk about enormous profits to be made from growing medicinal plants, all of which means nothing if it cannot be supported by positive concrete evidence of profits realized. Thus the medicinal plant garden, working perhaps along lines somewhat similar to those now being followed by the Bureau of Plant Industry, would collect trustworthy data on the cost of production and possible profits to be realized under the specific conditions existing in your state."

I have stated that other states have led in this enterprise, while Kansas has been apathetic. The schools of pharmacy of Philadelphia, Montana, Nebraska, Wisconsin, Minnesota, etc. have made this medicinal plant culture a very important

feature in their pharmaceutical and medical work. One of the most up-to-date gardens I have had the pleasure of examining is located at the University of Minnesota, where there is not only a garden of about three acres and a covered space of about three-fourths of an acre, but also a large greenhouse connected with the college of pharmacy, which the medical profession, as well as the drug trade, has seen fit to not only acknowledge of great value, but from a commercial as well as a scientific point of view it has been exceedingly beneficial in every respect.

I regret to say that the appeals of the dean of the school of pharmacy of the University of Kansas for a botanical garden for medicinal plants and for a properly constructed greenhouse thus far have not been permitted to come before the legislature. I feel that this is a very great mistake, but until we can convince the public that such a demand as I felt myself to be worthy of bringing to the notice of the legislature, we shall still remain as we are now, very backward in this most worthy enterprise.

University of Kansas, Lawrence.

ISOLATION OF TOXIC PRINCIPLES OF COFFEE, AND THE DETERMINATION OF THEIR TOXICITY.

L. E. Sayre.

In 1907 the writer published, in Merck's Report, an article on the toxic principle of coffee, and since that time, in the Transactions of this Society, he has had articles on the same subject, so that he has deemed it fit to present another article, bringing forth more recent work on the subject.

The cause of toxicity of coffee has long been a mooted question. At first the toxicity was believed to be due to caffeine, but it was quickly recognized that the symptoms that sometimes follow the use of coffee are not the same as those resulting from an equivalent amount of caffeine, as is seen from the following examples:

First. Persons who are affected with headache, insomnia, nervousness, etc., by the use of coffee are often similarly affected by the mere breathing of the vapors given off during the boiling of coffee.

Second. Persons not affected by coffee drinking, and even accustomed to the vapor given off during the roasting of coffee, have the ordinary symptoms due to the use of coffee through breathing the vapors driven off during the well-known vacuum treatment of coffee, or the roasting of this product.

Third. Persons unable to drink coffee without suffering the above symptoms are able to drink vacuum-treated coffee without suffering in the least.

M. Burmann also points out that, of the caffeine-containing plants, tea, kola nuts and coffee, the drinks prepared from those richest in caffeine produce the least disagreeable effects, and that coffee, which requires for preparation a process of roasting, produces the most disagreeable effects.

These and other similar facts prove almost conclusively that some other principle than caffeine is responsible for the toxic effects of coffee. So insistent has been the demands for an explanation of the cause of this toxicity that efforts have been made to assign it to the small amount of potassium salts which coffee contains, or to a new alkaloid in the green bean, which has not been isolated. But lately several investigations have been carried on in which an active volatile constituent has been separated from the roasted product. For this reason the fact is fairly well established that the toxic principle, as well as the aromatic principle, is due to the products formed in roasting. In the ordinary process of roasting, the green beans, continually agitated, are heated to a temperature varying around 210° C.

From a consideration of an analysis of green coffee by Konig, the effects of a temperature over 200° C. is quite evident.

Water	10.73
Nitrogenous substances	12.64
Caffeine	1.07
Sugar	8.62
Other nitrogen-free extractive substances	19.30
Dextrine	.86
Tannic acid	9.02
Crude fiber	24.01
Fat	11.80
Ash	3.02

Of these substances only moisture and caffeine are volatile, but since many nonvolatile vegetable substances decompose

below 200° C., the startling figures obtained concerning the effects of roasting can be readily believed. It has been found that over nine percent of organic material is lost while developing a light-brown color. The lost caffeine is but a fraction of one percent, and as the remaining organic substances can only escape by means of decomposition products, this result shows at least nine percent decomposition. How much takes place without escape of the resulting products cannot be stated.

The results of this decomposition and destructive distillation of the constituents of green coffee are, perhaps, as follows:

Carbohydrates yield furfuraldehyde.
Fats yield acrolein.
Tannins yield catechol, pyrogallol.
Caffetannic acid contains catechol.
Proteins contain ammonia, amines and pyrroles.

These products of roasting may also interreact to produce many compounds, such as—

Acrolein + ammonia = methyl pyridine.
Methyl pyridine + furfuraldehyde = furfural vinyl pyridine.

This latter compound will produce, on reduction, the alkaloid coniine, which is highly toxic and may be found in the coffee.

As a result of the above facts many investigators have tried to separate these products of roasting, mainly by steam distillation, and to give them careful examination as to the toxicity of the compounds found.

Bernheimer found hydroquinone, methyl amine, pyrrole and acetone. Erdmann has found furfuryl alcohol, mixed phenols, valeric acid and furfuraldehyde. Catechol has since been identified as being present. Hydrocarbons have been found that point to the presence of pyridine.

Mr. Paul D. Potter, chief chemist for Sprague, Warner & Co., has given us much information upon this subject, and among other things has given the following authoritative information on the toxicity of the various substances found in the volatile principle:

"Of the phenols, catechol is more toxic than carbolic acid, and pyrogallol is more toxic than catechol. The harmful influence of the pyridine bases increases with the molecular weight. According to Kendrick and Dewar, they constitute the toxic part of tobacco smoke, and Williams and

Walters have found that B lutidine affects the heart profoundly. Furfuraldehyde is considered to be the deleterious agent in raw spirits, and produces a persistent headache in doses of 0.096 grams. Furfuryl alcohol in doses of 0.5 to 0.6 grams per kilo of body weight will kill a rabbit. The symptoms are lowering of the body temperature, diarrhea and respiratory paralysis. If the nitrites are present, we have in them compounds which, according to Reid Hunt, approach the cyanides in toxicity. The reaction products which may be formed from substituted pyridines (or pyrroles) and furfuraldehyde are of exceeding interest in this connection, for their structural formulæ show them to be closely allied to the highly poisonous alkaloids such as nicotine and coniine.

"In considering the toxic influence of these compounds the possible presence of bodies built up by union of the primary decomposition products should not be regarded as far fetched. It is indeed difficult to account for the presence of pyridine in any other way. Further, although furfuraldehyde is the natural decomposition product of carbohydrates, furfuryl alcohol is the principal furane body in coffee oil. Active reducing conditions therefore exist within the coffee bean during roasting.

"It would also be erroneous to conclude that, since the flavor of coffee is due to roasting, all of the decomposition products are necessary to a good product. The flavor is, of course, due to one or more of them, but since it can be developed by longer roasting at a considerably lower temperature than is customary in commercial work, it does not follow that all of the decomposition products are desirable. In fact, Erdmann claims to have produced the aroma of coffee by heating caffeine, caffetannic acid and sugar.* It would therefore appear that the decomposition products of the proteins and fats are unnecessary and undesirable."

The toxic effect of all these bodies taken together gives coffee its toxicity. Burmann distilled coffee with steam and obtained these volatile constituents, which he examined for the physiological effect. He supposed he had a pure chemical compound, and called it "caffeotoxine." This, however, was proven later by Erdmann to be a mixture of compounds, as before stated.

Burmann's work, which was on treated coffee or that from which the volatile principle had been removed, shows undoubtedly that the injurious effects of coffee are from these compounds by his tests, which he sums up as follows:

(1) From a chemical point of view, treated coffee differs from untreated only in that it contains less of a volatile principle (caffeotoxine).

(2) From a physiological point of view, this constituent alone gives coffee its harmful effects.

(3) The volatile principle has a reducing action on the hæmoglobin; a depressing effect on the blood pressure; a de-

* This we have been unable to do.

pressing effect on the central nervous system, disturbing the cardiac rhythm; an action on the respiratory centers, causing dypsnea.

(4) The treated coffee contains in normal proportions all the elements of ordinary roasted coffee, with the exception of caffeotoxine, of which it contains only about one-third as much.

(5) The process mentioned (vacuum treatment or steam treatment) is said to eliminate the toxic substances, but not the other elements (fat, caffeine, etc.).

At the 1914 meeting of the American Pharmaceutical Association in Detroit, a paper, read by the author, stated that we had obtained reactions for pyridine in distillates of coffee, but we were unable to make more than an indefinite statement of this, for the reason that, while we had abundant evidence of the presence of pyridine, we had not actually separated it in the pure form.

During the past year in our laboratory we have paid especial attention as to whether pyridine could be separated in small quantities. In the paper referred to, published in the *Journal of the American Pharmaceutical Association* for January, 1915, it was stated that qualitative determinations of the pyridine-like bodies were possible by colorimetric methods, but during the past year we have endeavored to separate pyridine in pure state from finely pulverized roasted coffee. This we have succeeded in doing, even from small quantities of the pulverized roasted bean.

The process used consists in heating a quantity of finely pulverized coffee in a balloon flask contained in an oil bath at about 175° to 200° and connected to a suitable condenser and a vacuum pump by which a pressure of about 4 cm. of mercury was obtained. This distillate, when made strongly alkaline, yielded unmistakably pyridine.

It was thought that, notwithstanding these facts, possibly pyridine might be the result of destructive distillation rather than that this body preëxisted in the roasted coffee bean. In order to prove the latter was the case, namely, that pyridine preëxisted in roasted coffee and presumably was the result of roasting, the following experiment was performed. A few pounds of coffee were macerated for twenty-four hours with dilute hydrochloric acid and then percolated. The resulting

percolate was then concentrated and made strongly alkaline and steam distilled. From the distillate we recovered pyridine in the pure form.

In order to ascertain the activity of the concentrate in terms of its physiological action, the concentrate, which was the result of the dry distillation of coffee at a definite temperature and diminished pressure, was collected, hermetically sealed in glass ampules and sent to the laboratories of Parke, Davis & Co., where its toxicity was determined quantitatively by Doctor Hamilton in the biological laboratory of that firm.

Their report is as follows: "The results of our tests indicate that the minimum lethal dose of the concentrate, administered intraperitoneally, for frogs is 0.03 cc. per gram of body weight; for guinea pigs it is about 0.8 cc. per kilo of body weight."

We have just sent to the same biological chemist another lot of concentrate to have additional determinations made, *i. e.*, one to show the effect of internal administration by the mouth of the concentrate.

While coffee contains these toxic principles, it does not necessarily indicate, as some might suppose, that coffee is poisonous. Although some people are so constituted that they cannot use coffee, thousands of others use it without harmful effects, and even seem to receive benefit from its use. Therefore, we should not condemn coffee simply because the toxic principle, which has always existed, has been identified more certainly.

It might be said, in closing, that it is very probable that this toxic principle can be removed. In fact, a process is now in use (vacuum treatment) by which at least part of this principle is expelled, and by further experimentation the process can be further improved. It might be mentioned that this process of removing the volatile principle in the coffee is in exact contradiction to the former theory that it was desirable to retain the volatile principle in the coffee for its supposed aromatic effect.

For valuable collaboration in this work the author is indebted to his associates. Mr. G. N. Watson and Donald H. Lackey.

University of Kansas, Lawrence.

ARTIFICIAL RUBBER.

L. E. Sayre.

IN another paper presented at this meeting reference has been made to the subject of rubber in connection with corn oil. The writer had an opportunity of examining some splendid examples of artificial rubber made from corn oil as a starting point, exhibited at one of the recent meetings of the American Chemical Association at Urbana, Ill., and this has become such a matter of interest to the writer that he has thought it worth while to put into a compact form some of the points of value in connection with the subject.

It is safe to say that there are very few articles made of pure rubber. In the manufacture of rubber goods some sort of "mixings" or "fillings" or "compounding materials" are almost invariably employed. The mixings used are of various kinds, according to the use of the rubber, the color, surface and cost desired. Oils, waxes, especially paraffin wax, asphaltum and pitch, sometimes resins or shellac, are used in mixings. Of the fillings, whiting, plaster of paris, gypsum, the barytes, magnesia and litharge are the most frequent. Some of the synthetic rubbers or other substitutes for rubber are used with real rubber in the manufacture of rubber goods. I present here a sample of asphaltum such as is used in paving, and which has a value in the manufacture of commercial rubbers.

I also present here a rubber substitute, artificial rubber, so called, which on analysis proved to have the following composition:

Rubber	29 %
Asphalt compound	15
Lithiphone ($BaSO_4+ZnS$)	15
Litharge (PbO)	10
Sulphur	1

This rubber was used for the Schau cone tire, but this was proven to be, after some time, not a success. At present, in the making of these shoes 75 percent of rubber has been found necessary to give satisfaction. The composition of the rubber substitute is stated to be bitumen (Trinidad asphalt) and sulphurized oil. Bitumen is known in the trade as mineral rubber.

There are many different patents for artificial rubber, but none of these can as yet be regarded as really successful substitutes. The white substitutes are made from vegetable oils, usually rape or castor oil combined with chloride of sulphur in such a way as to completely saturate the oil. The chloride of sulphur is usually diluted with benzine. The brown or black substitutes are made by adding sulphur, *i. e.*, by the sulphuration of vegetable oil, usually oxidized oil. Adding vaseline and some mineral oil and paraffin wax before sulphurization is sometimes employed.

As before stated, corn-oil products producing rubber sponges and rubber materials of various kinds the writer has seen on exhibit. For exhibit, I present herewith a sample of rubber substitute made of corn oil, which has been vulcanized.

University of Kansas, Lawrence.

CORN OIL AND A NEW POINT OF VIEW IN FOOD VALUES.

L. E. Sayre.

At a former meeting of the Academy (1915) the writer presented a paper on corn oil, in which he endeavored to show the value of this product in making of medicinal preparations, and intimated that its use could be extended in various directions, not least among which was in the form of a dietetic as a salad oil and in salad-oil dressings. Since that time a very large number of experiments have been performed and further study of the subject of corn oil has been made.

Ever since corn has been used in large quantities for the purpose of the manufacture of starch there has existed a desire to recover the oil from the kernel, which would otherwise be wasted; and as the average Indian corn contains from 4 to 5 percent of oil, the importance was realized by the manufacturers of starch, as some of these used as much as from 20 to 40,000 bushels of corn per day. It is needless to say that the kernel or germ of the corn contains the oil, as has been before stated, to the amount of about 4 or 5 percent. In order to recover this the kernel must be separated, and then a process of hydraulic pressure is used. After the crude oil is recovered the process of refinement follows. This latter process has become very much improved, until to-day we have a product

which from the pure-food point of view is a remarkably fine article.

From one of the manufacturing houses I have obtained the following figures as to the output of corn oil last year: "Roughly speaking," the communication states, "last year 82,000,000 pounds of crude corn oil were produced in the United States, at least one-half of which was refined."

Becoming interested in this product, we have obtained large quantities of it for the purpose of distribution in order to ascertain whether the product was edible, and it is gratifying to state that in every case the report has been favorable as an oil suitable for salad dressing. A small amount is now used by some for making the camphorated oil, which is a solution of camphor in a fixed oil. It is also used in some of the leading biscuit and cracker plants in the United States and also by bread bakers throughout the country. Corn oil is also used in the manufacture of artificial rubber, attention to which will be called in another paper. The advantage to the cracker bakers in using the oil is evidenced by the constant changing of the large consumers from cottonseed oil to corn oil, which is due to its better keeping qualities and on account of its being more economical. The contention is made by the manufacturers that the corn oil is much cheaper to handle; being liquid, it can be pumped from one department to another or handled by gravity from overhead tanks, and makes an ideal shortening from a physical working standpoint.

The crude oil is largely used by soap makers, and sometimes by confectioners in oiling their slabs. The smoking point of the oil is very high, namely, 650° F., and lard 350° F., while refined cottonseed oil smokes at 500° F. When goods are cooked in or with fats having higher melting point a coating of fat is often formed over the other constituents, and the digestion of the proteins and carbohydrates is retarded, since the materials which are coated with a layer of fat will not be permeated readily by the saliva or the gastric juices. This is not the case when corn oil is used, due to its low melting point. Refined corn oil is stated to have the energy value of about 4,000 calories per pound, while butter, containing a considerable percentage of water and salt, shows usually only 83 to 85 percent of fat, with about 3,400 calories per pound.

It is worthy of note that the United States Department of Agriculture, in its Food Inspection Decision No. 169, issued

January 17, 1917, recognizes corn oil as edible, using the following phraseology: "Corn oil, maize oil, is the edible oil obtained from the germ of Indian corn, maize (*Zea mays* L.)."

In close connection with this subject the author will present another paper on corn-starch flour, which is mentioned here merely because this product, in connection with the oil, has grown to be of considerable importance from the standpoint of food economy. If corn flour can be used with a high-protein flour in bread making, it is safe to say that this fact will have a decidedly valuable commercial bearing, reducing the cost of bread and at the same time increasing the value of the corn products; but this whole question must be studied from the point of view of nutritive values, and inasmuch as bread, as well as corn oil, is dependent upon peculiar elements of nutrition, it may be not out of place to state the new point of view in regard to food values. A few salient and outstanding facts only can be referred to in this paper. Suffice to say that in discussing foods we think of them, first of all, in terms of their value in maintaining body weight, of maintaining body heat, and of their power to promote normal body growth. Foodstuffs, we say, contain five essential constituents—proteins, fats, carbohydrates, salts and water. The former of these constituents we associate with the reconstruction of depleted and broken-down cellular protoplasm. Carbohydrates and fats we think of primarily as energy producers, intimately concerned with heat production. Salts maintain osmotic and acid and base-equilibrium, and also enter into the structure of the complex cell molecule. Water is the all-important "disperse medium" for the complex colloid which we to-day know the cell to be.

But when we have finished analyzing the composition of foods for man and animals on this basis we have only come to the beginning of the knowledge developed during the last few years. The splendid work of Osborne and Mendel at the Connecticut Experiment Station and Yale University has brought out very clearly that so far as the protein constituents of foods are concerned, the amino acid and not the individual proteins are of first importance. It matters far more which of the amino acids are present than how much of them a food may contain. Of the twenty-odd amino acids found in various food

proteins, two of them, lysine and tryptophane, have been shown to be indispensable in maintaining body weight and producing normal body growth. This fact alone must profoundly modify our ideas on the nutritive values of food stuffs. Practically the beginnings are now being made and we may well look to the immediate future for a much larger application of this knowledge.

Side by side with our advances on the amino acid contents of foods has come the realization that certain other constituents of foodstuffs are intimately concerned with their nutritional value. The work of McCollum and his coworkers at Wisconsin has shed much light on this phase of nutritional investigation. They have succeeded in isolating two substances, one water soluble, the other alcohol soluble, which play important and indeed essential roles in maintaining normal growth and development in animals. Nothing as to the composition of these two substances is known, and they have been labeled for the present as water-soluble A, and alcohol-soluble B. This work constitutes a second link in our understanding of the chain of nutritional metabolism. It may safely be said that the future has many surprises in store for us along these lines. If there is one thing we may profit by as a result of the late investigations mentioned it is the fact that the little heretofore considered unimportant constituents may play a role quite as profound as do the more obvious and abundant ones.

University of Kansas, Lawrence.

FOREIGN ADDITIONS TO OUR DIETARY.

E. H. S. Bailey.

TO WHAT extent are we dependent upon foreign markets for our food supply? This question, more than ever before, has recently impressed itself upon the people of the country. It is often this question which determines whether a nation shall stand or fall in a great struggle. Is that nation self-contained as to her food supply? Has she resources within herself so that if all outside provisions are cut off by a blockade her inhabitants will have sufficient food?

Every one realizes that the quantity of a given food can be greatly increased by planting increased acreage, as well as by more intensive farming. The variety may also be enlarged by the introduction of foods which are not at present grown in this country. Notwithstanding our immense food resources, there are some products which have always been obtained from foreign sources. This is partly due to the fact that we have no strictly tropical climate, and partly because we have found it easier to buy products abroad than to develop the cultivation of them at home. Of course, every country is supplied to some extent with foreign foods. In some countries, as in the British Isles, a large proportion of the foods come from outside sources. They can never be independent of other lands.

Some staple foods are necessary to subsistence; with those we are fairly well supplied. It is true that, if isolated, we should have to double our sugar production to be comfortable, or live on less sugar per capita, as many other nations do. Besides the staple foods, there are numerous fruits and vegetables and many luxuries which add a wholesome variety to the diet, and which would be missed if they could not be obtained. Many of these come from abroad.

Food products, considered in a large way, may be classified as follows:

(1) Those products produced in the United States in abundance, and which are seldom imported from a foreign country.

(2) Those foods which are produced here, sometimes in sufficient quantities so that we export them, and which are sometimes so scarce that they must be imported.

(3) Food products that are produced in the United States, but never in sufficient quantities to supply our needs.

(4) Products grown in limited quantities, or not at all here, and which must be practically all imported.

(5) Foods which, because a taste for them has not been cultivated here, or because no way has been discovered for transporting them to this country, or since they are extremely perishable, have not been imported.

The above classification does not include reports from what the Bureau of Foreign and Domestic Commerce calls "non-contiguous territories." If the islands which have come under the control of the United States in quite recent years, such as the Philippines, Hawaii and Porto Rico, be included in the United States, the quantity of foodstuffs imported will be quite sensibly diminished, and the variety of those imported will be much less.

Those foods which are of the most interest are those found in classes (3), (4) and (5). Class (3), "Food products produced in the United States, but never in sufficient quantities to supply our needs," contains varied products which increase and decrease from year to year. Those foods which are both exported and imported in practically equal quantities are not of special interest in this connection.

One of the first foods to consider in class (3) is sugar. Although both cane and beet sugar have been cultivated here for many years, yet the supply is very far from equaling the demand. According to the report for 1914-'15 of the amount of sugar consumed, 22.5 percent is raised in this country; 25.4 percent was raised in the noncontiguous countries, mentioned above, leaving 52.1 percent to be imported from foreign countries. Most of this supply formerly came from Germany and central Europe, where it was made from the sugar beet.

In regard to rice, although we raised over 23,000,000 bushels of rice in 1914, yet we import five times as much in order to supply our consumers. This comes largely from India and China.

We can raise a large variety of nuts in this country, but we import more than 44,000,000 pounds of peanuts annually, to say nothing of the peanut oil which is brought in. The peanuts come especially from tropical islands and the African coast. Walnuts, known as English walnuts, can be readily

grown in some parts of the United States, yet we import 37,000,000 pounds annually, and these come mostly from Spain and Southern Europe. The growing of almonds has been tried with success in some sections of the country, still we are importing 19,000,000 pounds annually. A large proportion of our lemon oil comes from southern Italy, especially from Sicily, experiments are being carried out by the Department of Agriculture looking to the production of lemon oil from the groves of Florida and Southern California.

Macaroni is another product the manufacture of which is rapidly increasing in this country, and there is no reason why practically all the macaroni used should not be made here. According to the latest reports we import 126,000,000 pounds yearly.

There are only a few sections of the country in which olive oil is produced, but this production could no doubt be largely increased. At present we are dependent upon Italy and the countries around the Mediterranean Sea for 7,000,000 gallons of olive oil annually.

There are some vegetables that, notwithstanding our immense facilities for growing them in this country, still come from abroad. This is especially the case with the tomato products from Italy and certain high grades of preserved fruits from France and Belgium. Early onions and potatoes are also imported from the West Indies, so that the total value of vegetables coming in in this way was $9,108,036.

Foreign beer, wines and liquors have always been favorites on this market. In regard to these it should be said that, as they are made under peculiar conditions, and by experts, they cannot be so completely imitated that the flavor of the American article will be as fine as that of the foreign product. This bill amounts to $20,000,000, of which one-half is for wines.

As previously stated, class (4) contains those products which are grown in limited quantities or not at all in this country. The necessity for importation is, in most cases, because our climate is not suitable for the growth of these products.

Cocoanuts, which are dried and shipped in immense quantities to this country under the name of "copra," come from the East and West Indies, Africa and other tropical countries. Copra is pressed for its oil, a product that is coming into use

as a food product and for the manufacture of soap. The amount of cocoanut products imported for the year ending June 30, 1914, was 55,734,709 pounds.

In addition to these nuts we imported during the same year $24,000,000 worth of vegetable oils. These are used both for food and for manufacturing purposes. They include such oils as cocoa butter, cocoanut oil, cottonseed oil, nut oils, palm oil, palm-kernel oil, rapeseed oil, and soy-bean oil. Here again the amount imported during the last two years has been much affected by the difficulty of securing vessels for transportation on account of the disarrangement of commercial conditions by the war.

Most of our spices, including especially cinnamon (cassia), ginger, pepper and cloves, come from the East Indies, though some other tropical countries contribute small quantities. The total amounted to 56,574,499 pounds in 1914.

Another product which is not grown in this country, and for which we must rely upon semitropical countries, especially Mexico and Central America, is the vanilla bean. We imported these to the value of $2,677,675.

There is no reason why mushrooms could not be raised here if we had people who were sufficiently expert in handling them. It is well known that they require certain conditions of moisture, and above all an equable temperature. The absence of light is not a matter of much importance, although in order to secure an even temperature they are frequently raised in cellars. Our mushrooms come mostly from France and Central Europe and amount to $1,306,818 in a single year.

In order to satisfy the taste of our people for cheese of a special flavor it has been found profitable to import cheese to the amount of 63,784,313 pounds, valued at over $11,000,000. Many of these cheeses are made under peculiar conditions of temperature and climate. Some are made from goats' milk; some are ripened for a long time in caves, where the conditions are ideal for producing a particular flavor; so that altogether it has been found difficult to exactly imitate the foreign cheese in this country.

It is true that we raise an abundance of fruits in this country, but a great variety is acceptable to the people and is indeed an advantage in the dietary. Some of these foreign fruits imported are extremely valuable as foods, and they should be so

classified rather than as fruits used simply for dessert. The most important, in the matter of quantity, of all the fruits imported is the banana. The quantity of bananas imported during the last two years is not as great as it was in the year ending in September, 1914, on account of the fact that it is difficult to secure vessels for transporting them. For the year ending September 30, 1914, there were imported 47,022,178 bunches, and these were estimated to contain 6,601,913,791 individual bananas, or fingers, as they are called. This would give an average of 66 bananas per capita for the people of the whole United States. The growth of the banana industry is phenomenal, and they are being more and more utilized for cooking in various ways. It is gradually coming to be known that the banana is as valuable a food product as the potato, and more valuable than many other vegetables that we use.

One of the most concentrated food products which we import is the date. This grows on a species of palm in comparatively rainless countries around the Mediterranean Sea, in Africa, and in Asia. The quantity imported in the year ending June 30, 1914, was 34,073,608 pounds.

Figs should also be classified as belonging to the list of very cencentrated foods. Their nutritive material consists largely of fruit sugar. In the year mentioned, 19,284,868 pounds were consumed. In addition to these we import of lemons more than $2,000,000 worth, of pineapples $1,000,000 worth, and more than 4,000,000 pounds of raisins.

The substances used for making the slightly stimulating, nonintoxicating beverages — tea, coffee and chocolate — are practically all imported. From China, Japan and India we obtain practically all the tea used, which amounted to 91,130,815 pounds for the year ending June 30, 1914. This tea is examined by the United States customs officials at the ports of entry, so unless adulterated in the hands of the jobbers it is of good quality and unadulterated.

The people of this country are especially a coffee-drinking race, and used 1,001,528,317 pounds of coffee in the year mentioned. Very little of this comes from the eastern hemisphere at the present time, except possibly small quantities from Africa. More than three-fourths of the coffee is raised in Brazil, in the northern part of South America, and in Central America.

The taste for the cocoa products, including chocolate, is gradually increasing since it was first introduced in this country about 150 years ago. The cacao bean, from which cocoa and chocolate are made, is grown especially in Mexico and tropical sections of South America. The amount consumed annually is 179,364,091 pounds.

The total value of foodstuffs imported annually is over $380,000,000. It is evident that all of this is not by any means a necessary addition to our food supply, but it is imported because trade conditions make it profitable to do so.

The United States Department of Agriculture is doing a commendable work in sending agents to different parts of the world to search for food plants that may be profitably grown in the United States and in encouraging the cultivation of some little-known plants. Some of these will no doubt ultimately be cultivated here in large quantities, and will in this way decrease the dependence of this country on a foreign food market.

University of Kansas, Lawrence.

ON THE OCCURRENCE OF STARCH IN GREEN FRUITS.

E. H. S. Bailey and W. S. Long.

IT IS well to remember at the outset that the chief source of the vegetable food of man is the seeds, seed receptacles, and roots of plants. In making arrangements to reproduce its kind, roots, tubers, seeds, fruits and vegetables each has its own way of attaining the desired result. In tubers, like the potato, there is a great storehouse of starch and other nutrients, and on this the young plant lives until it finds suitable soil in which to grow and continue an independent existence. Grains consist of a storehouse for starch and other nutrients to start the young plant. Some roots, as the beet, containing starch and sugar, have been cultivated for their sugar content, and very much improved in this particular. Fruits, as they ripen, change in composition; the starch is changed to sugar, the harsh tannic acid is replaced by sugar, and the fruit acid—malic, citric, or tartaric—is often much diminished in quantity. These changes are well shown in the analysis of Baldwin apples as published by the Pennsylvania department of agriculture:

	Very green.	Green.	Ripe.	Overripe.
Invert sugar	6.40	6.46	7.70	8.81
Sucrose	1.63	4.05	6.81	5.26
Total sugar by addition	8.03	10.51	14.51	14.07
Starch	4.14	3.67	0.17	.....

The free malic acid in the "very green" apples was 1.14 percent, and in the overripe apples only 0.48 percent.

Some interesting experiments on the persimmon were made by the Bureau of Chemistry of the Department of Agriculture. The astringent taste of the green persimmon is due to the presence of tannic acid, which in the process of ripening is probably changed to sugar. It was learned that the Japanese ripen persimmons artificially by putting them into an empty "Saki" cask, from which the beer has been recently removed. A few lumps of dry starch are also placed in the cask. A study of this process revealed the fact that the ripening was due to the carbon dioxide which remained in the cask, and the starch removed the excess of moisture. So this fruit can now be and is successfully ripened in an atmosphere of carbon dioxide.

We do not expect to find starch in ripe fruits. Even the banana, which when picked green contains about 14 percent of starch, when ripened by modern methods of storage contains only .71 of 1 percent of starch. The green banana is used as a starch-producing food, and the banana flour made from it is utilized by cooking in cakes, gruel and similar products. One reason, although perhaps not the only one, why bananas are by some considered unwholesome is because they are eaten raw, when they are not sufficiently ripened—when they still contain starch. We do not consider raw starch a wholesome food; except in small quantities, it is not as readily digested as when cooked. The yellow banana, when ripe, is usually mottled with black and yellow spots. The odor of the unripe banana is also radically different from that of the ripe fruit.

It might be urged that nuts contain considerable starch, and that we eat them without cooking. It should be noted, however, that those nuts that contain the most starch happen to be the ones most frequently cooked before serving. Acorns are not generally eaten by civilized people; chestnuts, when actually used as food, as in Italy, are usually cooked; and peanuts are roasted before they are edible.

In studying the composition and source of some of the commercial fruit jellies on the market, we observed that some special samples contained what seemed too much starch, so much in fact as to suggest that starch might have been added as a thickener. On further investigation, however, it was learned that while some jellies are made directly from apple juice as a base, later in the season, when apple juice was not available, apple trimmings were used. These apple trimmings are a by-product from the fruit evaporators, and consist of dried skins and cores. These, when examined separately, contain from four to five percent of starch.

There are but few references in literature to starch in fruits. One author states that starch was found in preserves made from bruised apples.[1] The chemical composition of American Food Products,[2] although giving the composition of various food products, makes no mention of the occurrence of starch in any fruits, probably because the ripe fruits only were considered.

1. Worcallier, Cause of Abnormal Quantities of Starch in Bruised Apples, Jour. Soc. Chem. Ind., vol. 24, p. 981.
2. U. S. Dept. of Agric. Bul. 38.

The Pennsylvania department of agriculture,[3] under the title, "A Chemical Study of the Apple and Its Products," gives the following in reference to starch in apples:

Very green apples	4.14%
Green apples	3.67
Ripe	0.17
Overripe apples	....

It would hardly be supposed that green apples would be used for making evaporated or dried apples. One sample of jelly labeled as made from corn sirup and apple, which was in reality made from corn sirup and apple trimmings, contained .7 of 1 percent of starch. As this jelly contained 34 percent of water, the starch paste was about a 2 percent solution. This preparation of dry starch goes quite a way towards thickening a product. It is not assumed, however, that the manufacturer of a fruit jelly desires to have starch as one of the constituents of his product, for starch ferments readily, and would tend to make the product spoil more quickly. The starch is, of course, a cooked starch in the finished product, so it would not be easy to tell what its source was, whether from the fruit used or from some other source. It seems, therefore, that it will be necessary to allow these commercial jellies to come on the market, even if they do contain small quantities of starch. In case they are made from apple trimmings the fact should be stated on the label. We shall, at the proper season, test some green fruits to learn something more definite as to their starch content.

University of Kansas, Lawrence.

3. Bulletin Penn. Dept. Agr. 38.

THE COMPOSITION OF COMMERCIAL FRUIT EXTRACTS.

WALTER S. LONG.

ACCORDING to federal and state standards, a flavoring extract is a solution, in ethyl alcohol of proper strength, of the sapid and odorous principles derived from an aromatic plant, or parts of the plant, with or without its coloring matter, and without added coloring matter, and conforms in name to the plant used in its preparation.

There are on the Kansas market a large number of products which are represented and labeled as fruit extracts. There are, for example, extracts of strawberry, pineapple, blackberry, raspberry, cherry and banana. Some work has been done at the food laboratory of the State Board of Health at Lawrence with the view of securing data which would serve as an aid in determining the genuineness of such products.

The commercial products themselves were first subjected to analysis. These were found to be weak alcoholic solutions, leaving on evaporation a sirupy residue, which on burning left an ash. Analysis of the ash showed it to have the characteristics of the ash of fruits. On treating the original extract with subacetate of lead a heavy precipitate formed, showing the presence of solids other than sugars in solution.

On the basis of the information thus gained, alcoholic extracts of various fruits were made in the laboratory. The process consisted in macerating the whole fruit, finely ground, for a week or more with strong alcohol, then pressing out through cheese cloth and finally filtering through paper. These clear extracts were then analyzed. A comparison of the data thus obtained with that from the commercial products showed a very close agreement, as shown in the tables at the close of this paper.

To determine in what respects, if any, an alcoholic extract of a fruit differs from the fruit juice itself, analysis was made of an extract of the fruit in whose preparation water was used instead of alcohol. The results showed no appreciable difference except in the alcoholic content.

To show the effect of glycerine and sugar together with alcohol as extractive agents, extracts of this nature were pre-

pared and analyzed, with results similar to those obtained with alcohol alone or water alone.

The above remarks and conclusions are based upon analysis representing determinations of alcohol, total solids, total ash, soluble and insoluble ash, total alkalinity of ash, and the alkalinity of the soluble ash. These serve as aids in establishing an extract as a fruit product only, and give no information regarding the identity of the extract or its value as a flavor. As a means of differentiating between extracts of various fruits, it was found in the case of the laboratory-made extracts that certain reagents when added directly to the extracts gave characteristically colored precipitates. For example, a mixture of alum and sodium carbonate gave for pineapple a white precipitate, for strawberry a cream-colored precipitate, for raspberry a brown, for cherry a bluish gray, and for blackberry a deep blue. Similar results were obtained with normal lead acetate and basic lead acetate, the colors differing from those in the case of alum, but being quite as characteristic.

To determine the value of the extracts as flavoring material, rather extensive tests were made by the department of home economics at the University. These tests showed conclusively that these extracts are practically worthless as flavoring agents for pastry products. These results were anticipated from the fact that, with possibly one exception, namely, the extract of pineapple, it is impossible to identify these products by taste or odor.

In short, fruit extracts are flavors in name only. They contain no "sapid and odorous principles derived from an aromatic plant or parts of the plant." In this respect they fail to comply with the legal standards. However, they do contain the plant's coloring matter, and this in abundance, and in this respect they conform to the standard and to the name of the plants used in their preparation.

TABLE I.—*Commercial fruit extracts.*

No.	Alcohol, vol.	Grams per 100 cc.			cc. N-10 acid per 100 cc.		Percent ash in solids.	Normal lead No.
		Solids.	Ash, solids.	Ash.	Alk. total ash.	Alk. sol. ash.		
				PINEAPPLE.				
1	34.20	16.78	0.74	0.64	63.5	42.0	4.41	1.624
2	27.60	14.37	0.58	0.43	70.2	38.2	4.04	1.526
3	33.43	12.34	0.09	.....	.....	.....	6.73	0.200
4	35.90	16.56	0.73	.....	.....	.....	4.41	1.740
5	36.24	18.09	0.71	.....	.....	.....	3.93	1.740
				STRAWBERRY.				
6	33.95	8.64	1.00	0.88	73.5	51.0	11.57	1.885
7	34.50	8.94	0.60	.....	.....	.....	6.71	2.160
8	45.20	1.17	0.36	0.31	20.3	6.8	3.08	.....
9	32.20	7.17	0.59	0.47	79.6	51.1	8.23	1.881
				RASPBERRY.				
10	41.53	24.27	0.72	.....	.....	.....	2.97	1.400
11	30.60	21.37	0.44	0.33	55.5	30.0	2.06	1.437
12	42.40	2.57	0.02	0.016	17.5	5.5	0.80	.....
13	48.20	5.15	0.07	0.02	13.7	2.7	1.30	.....
14	25.80	5.20	0.09	0.03	16.7	6.2	1.00	.....
15	41.00	23.26	0.70	0.58	81.0	51.0	3.00	1.881
				CHERRY.				
16	34.60	17.57	0.69	0.58	88.5	69.0	3.98	1.218
17	29.00	8.09	0.35	0.25	53.5	35.5	4.32	.....
18	31.23	17.72	0.64	.....	.....	.....	3.61	1.220

Numbers 8, 12, and 13 were labeled as imitation extracts.

TABLE 2.—*Laboratory-made extracts.*

No.	Nature of extractive agent.	Alcohol vol.	Grams per 100 cc.			cc. N-10 acid per 100 cc.		Ash in solids.
			Solids.	Ash.	Sol. ash.	Alk. ash.	Alk. sol., ash.	
			PINEAPPLE.					
19	Alcohol	43.65	7.00	0.24	0.17	38.5	23.5	3.43
			BLACKBERRY.					
20	Alcohol	45.20	7.81	0.34	0.25	47.1	23.1	4.35
			STRAWBERRY.					
21	Alcohol	52.34	2.43	0.25	0.22	24.8	19.5	10.10
22	Alcohol	28.73	1.91	0.12	0.11	16.5	13.0	6.13
23	Alcohol + Glycerol	52.04	10.86	0.19	0.17	20.8	16.0	.....
24	Alcohol + Glycerol	48.42	12.92	0.20	0.18	20.0	15.3	.....
25	Water	1.46	6.18	0.18	0.16	30.5	24.0	.....
			CHERRY.					
26	Alcohol	49.90	8.37	0.27	0.23	30.3	25.3	3.19
27	Alcohol	29.24	7.78	0.26	0.23	29.5	26.5	3.35
28	Alcohol + Glycerol	51.23	15.14	0.24	0.22	28.5	23.8	.....
29	Alcohol + Sugar	49.95	18.11	0.28	0.25	30.2	24.5	.....
30	Water	0.32	8.00	0.33	0.29	.....	35.0	.....

Note proportion of material used in—

(*a*) Alcoholic extracts:

(1) Fruit, 50 percent; strong alcohol, 50 percent.

(2) Fruit, 50 percent; strong alchol, 25 percent; water, 25 percent.

(*b*) Alcohol-glycerol extracts: Fruit, 45 percent; alcohol, 45 percent; glycerol, 10 percent.

(*c*) Alcohol-sugar extracts: Fruit, 45 percent; alcohol, 45 percent; sugar, 10 percent.

(*d*) Water extracts: Fruit, 50 percent; water, 50 percent.

TABLE 3.—*Volume and color of precipitates and color of filtrates with precipitation reagents.*

	Basic lead acetate (Sp. Gr. 1.25).			Normal lead acetate (80 gms. per l.)			Alum and sodium carbonate (60%).		
	6 vol.	*Lake.*	*Fil.*	*Vol.*	*Lake.*	*Fil.*	*Vol.*	*Lake.*	*Fil.*
Pineapple	3 5	Light cream	Colorless	2.20	Light cream	Colorless	0 80	White	Nearly colorless.
Strawberry	3 5	Gray	Colorless	2.30	Flesh	Pink	0.60	Cream	Reddish.
Raspberry	5 3	Dark gray	Colorless	3.50	Chocolate	Dark read	0.30	Brown	Dark red.
Cherry	3.2	Light green	Colorless	2.00	Gray blue	Pink		Gray blue	Red.
Blackberry	2 9	Green-blue	Colorless	2.40	Dark blue	Purple	1 00	Blue	Deep purple.

NOTE.—The method used to obtain the results indicated in the above table was as follows: 5 cc. of the extract and 2 cc. of the reagent were placed in a Hortvet tube, thoroughly mixed and centrifuged for five minutes, and the volume and color of precipitate and color of supernatant liquid noted. Volume is expressed in cc.

UNIVERSITY OF KANSAS, LAWRENCE.

THE RELATION BETWEEN THE QUANTITIES OF TIN AND HYDROGEN IN "SPRINGERS."

WALTER S. LONG.

A SEARCH of the literature available on this subject reveals very little from a bacteriological standpoint and not a great deal from a chemical point of view.

A gas-producing organism having the characteristics of *B. putrificus coli* was isolated from "swells" containing meat by Fowler in 1908[1].

Tonney and Grooken[2] attributed the presence of carbon dioxide and alcohol in canned goods to alcoholic fermentation, which occurs as a result of imperfect sterilization. The presence of nitrogen they attributed to protein decomposition, claiming that the amount of this gas is an index of the amount of such decomposition. They found hydrogen present in amounts varying from none to 48 percent. Its presence was an indication of ptomaine-producing substances. Marsh gas, which occurred in small amounts, had the same significance. Carbon monoxide, which occurred occasionally, was formed by the reduction of carbon dioxide by nascent hydrogen. Oxygen, occurring in traces only, was present as a constituent of air. They found extreme variations in the kinds and amounts of gases in the same types of foods.

J. M. Coerbergh[3], working with canned spinach, found that the amount of tin in material put up in cans, by the same maker and at the same time, may vary greatly. The amount in unvarnished cans one year old was less than 126 mgs. per kilogram of food, while the amount in varnished cans was always much less. He found that the amount of tin bore no relation to the amount of air or of nitrates in the cans.

R. F. Bacon, in an article entiled "Tin Salts in Canned Goods of Low Acid Content"[4], states that many nonacid foods attack tin linings to a very marked extent. A determination of the ratio of tin to acid in a number of canned foods showed that this ration was highest in nonacid vegetables and lowest in acid

1. Third Report of the Committee on Physiological Effects of Food, Training and Clothing on the Soldier, 1908, 49-51.

2. "Analysis of Gases Contained in Swollen Canned Goods," American Food Journal 3, 1908.

3. Pharm. Weekblad 49, 429-31, 490-495, Chem. Abs. 1912.

4. U. S. Dept. Agri., Bur. Chem., Circular 79, 1911.

fruits and vegetables. He found that shrimps contain a corrosive substance which attacks tin vigorously. The compound $N(CH_3)H_2$ isolated from this product dissolved tin slowly. He investigated the action of several alkaline substances, amino acids and purine bases, and found that many of these substances would dissolve tin in considerable quantities. His conclusion was that the action of nonacid foods was due to amines and amino acids.

W. Rossee and Von Morgenstern, in an article entitled "Abnormal Amounts of Tin in Canned Foods,"[5] state that canned foods always contain some tin removed from the receptacle, but usually only small amounts. Large amounts are dissolved when the can is left open for some time. Canned spinach, originally containing 18 mgs. of tin, after six days' exposure contained 1,038 mgs. per kilo. Similar results were obtained with other vegetables. They state that the tin forms insoluble compounds with the vegetable substance, and is not redissolved by the gastric juice. Their conclusion is that the small amounts of tin usually found in canned foods are not to be considered injurious.

H. A. Baker, in his article, "The Disappearance of Oxygen in Canned Food Containers,"[6] states that the gases in the head space of "springers" are never more than three—carbon dioxide, nitrogen and hydrogen. He defines the term "springer" as "a trade name given to cans with bulging ends, which contain perfectly sound and sterile food products." The source of these gases he states as follows:

Carbon dioxide is produced during the time of processing, and may be produced in excessive amounts if the time from the beginning of the preparation of the material to the period of sterilization is not short.

Nitrogen is present as a residue from unremoved air.

Hydrogen is present as a result of the action of fruit and vegetables acids on metallic containers.

The disappearance of the oxygen originally present as a constituent of the air left in the head space of the container he attributes to at least three causes, as follows:

(*a*) It may combine with the metals tin and iron, forming oxides.

5. Z. offentl. Chem. 20, 171-172, 1914.
6. Original Communication, Congress of Applied Chemistry, vol. 18, 1912.

(*b*) It may be used up in the oxidation of salts of these metals.

(*c*) It may combine with nascent hydrogen.

(*d*) It may combine with fatty materials during processing.

A. W. Bitting, in "Methods Followed in the Commercial Canning of Foods,"[7] states: "It is always possible to tell a 'swell' from a 'springer' by the use of a microscope, as in the former there will be large numbers of organisms, while in the latter there will be very few." It will be inferred from this statement that cans which are "bulged" only as a result of the presence of hydrogen formed by the action of acids on tin are to be considered as "springers."

W. D. Bigelow, in the September, 1916, *Journal of Industrial and Engineering Chemistry*, points out that tin in canned food is largely, sometimes chiefly, in the form of insoluble compounds; that the acid acts as a carrier of tin from the coating of the container to the food material.

In the November *Journal* the same author states that with nonacid foods such as peas or corn, swells are usually due to decomposition. On the other hand, spoilage rarely occurs with acid fruits unless the can be leaky. In this class of products swelling of the can is almost invariably due to hydrogen set free by the action of the fruit acid on the metal of the container.

This review of the literature on the subject shows that no work has been done on "springers" and "swells" involving the quantitative determination of tin and the various gases. It seemed desirable, therefore, to secure some data of this nature.

If the hydrogen present in canned foods is the product exclusively of the action of acids on the tin of the container, then obviously there should be a definite relation between the amounts of tin and hydrogen present. If the hydrogen is partially the product of the action of acid on other metals of the container, such as iron, then the hydrogen present should be greater in quantity than that capable of being liberated by the tin present. To obtain information in regard to this matter, determinations were made for tin and the various gases in eighty-three samples of bulged canned goods. These represent the following products: corn, pumpkin, sweet pota-

7. U. S. Dept. Agri., Bul. 196, 1915.

toes, greens, tomatoes, peaches, apples, hominy, beets, kraut, asparagus, blackberries, raspberries, strawberries and cherries. The tables appended contain the results obtained. For the sake of ready comparison the tin is expressed in milligrams per kilogram of food and the gases as cubic centimeters per kilogram.

The term "excess gas," as used in the tables, is to be interpreted as meaning the amount of gas given off by the can during the equalization of pressure.

The volume of gas remaining in the can was obtained from measurements of the total volume of the can and the volume of the food contents.

The tin determinations were made by the iodine titration method, as outlined by H. A. Baker in his article "Special Adaptation of Iodine Titration Methods for the Estimation of Tin, Especially in Connection with Determinations of 'Salts of Tin' in Canned Foods," published in "Original Communications, Congress of Applied Chemistry."

An examination of the table will show that:

1. In the majority of cases the gases present were hydrogen, carbon dioxide, and nitrogen (the inactive residual gas being considered as nitrogen). The presence of these three gases alone, coupled with the fact that the condition of the food in 90 percent of the samples was good, judged by the taste, smell and appearance, suggests that the samples examined were "springers."

2. No definite relation exists between the amounts of tin and hydrogen.

3. The hydrogen in nearly all cases is a small fraction of the amount which the tin present is capable of liberating by interaction with acids.

These facts suggest that considerable tin is corroded by agents other than acids.

4. The amounts of carbon dioxide present in the majority of samples are relatively large. Whether these amounts are formed during processing, or subsequently as a result of fermentation, has not been determined.

5. There is a wide variation in the amounts of tin and gases in the various kinds, and also in the same kind of foods.

Amounts of tin and gases in bulged canned goods.

Contents, grams.	Excess gas, cc.	Total gas, cc.	Tin per kilo, mgs.	Gases per kilogram of fruit.		
				Total cc.	Hydrogen cc.	Carbon dioxide cc.
CORN.						
603	100*	170*	79	281	11	185
617	83	163	45	264	169	144
595	41	116	265	194	91	61
585	25	115	34	196	6	27
PUMPKIN.						
957	87	167	822	175	6	161
SWEET POTATOES.						
588	22	.....	158	.....	Present	Present
546	74	.....	292	.....	Present	Present
GREENS.						
762	.....	.....	213	.....	Present	Present
773	100*	100*	339	.....	Present	Present
TOMATOES.						
588	7	42	117	71	.....	19
843	52	77	93	91	58	16
PEACHES.						
.....	70	329	324	.....	.....	Present
840	29	129	163	154	97	3
840	45	135	91	158	83	5
840	65	225	109	267	180	8
812	63	173	245	213	122	6
883	5	150	113	.....	.....	.....
843	1	.....	163	.....	.....	.....
826	21	96	185	116	18	.....
MOLASSES.						
1112	100*	.....	53	.....	.....	Present
APPLES.						
720	.....	.....	538	.....	.....	.....
HOMINY.						
964	100*	100*	38	.....	Present	Present
1000	.....	.....	53	.....	.....	.....
BEETS.						
957	100*	100*	186	.....	Present	Present
KRAUT.						
953	45	90	56	94	3	27
ASPARAGUS.						
937	.....	.....	320	.....	.....	.....

* Not a swell.

Amounts of tin and gases in bulged canned goods—concluded.

Contents, grams.	Excess gas, cc.	Total gas, cc.	Tin per kilo, mgs.	Gases per kilogram of fruit.		
				Total cc.	Hydrogen cc.	Carbon dioxide cc.
BLACKBERRIES.						
.....	85	.....	386	.....	Present	Present
528	27	82	380	155	97	16
588	45	100	520	170	91	13
567	36	116	490	204	54	42
588	97	172	918	293	236	52
542	41	111	170	214	134	52
581	37	102	485	176	96	30
557	54	144	543	259	163	63
546	41	136	626	249	156	88
578	23	83	490	144	64	18
.....	33	.....	427	.....	Present	Present
588	77	152	779	266	185	33
588	38	113	508	192	124	18
581	44	99	371	167	109	13
592	100*	100*	927	.....	Present	Present
581	30	90	684	155	102	21
588	24	79	455	134	58	20
539	36	141	722	262	174	31
581	59	119	605	205	135	16
576	.....	.....	332	.....	.....	.....
.....	43	.....	251	.....	Present	Present
578	29	64	421	111	53	18
576	37	77	254	133	68	22
.....	55	.....	454	.....	Present	Present
588	52	107	430	182	118	20
576	28	88	406	152	87	20
560	.....	.....	226	.....	.....	.....
576	.....	.....	347	.....	.....	.....
.....	.....	.....	96	.....	.....	.....
570	28	58	55	109	81	9
546	75	120	31	219	206	12
581	47	82	107	141	25	9
613	62	100	194	163	124	8
585	54	99	335	169	142	9
578	.....	.....	475	.....	.....	.....
563	40	110	633	195	99	30
576	.....	.....	294	.....	.....	.....
574	4	69	311	.....	.....	.....
RASPBERRIES.						
.....	.....	.....	219	.....	.....	.....
617	41	86	126	140	92	19
549	43	133	84	242	160	24
617	58	93	59	151	130	11
617	43	83	127	135	108	12
599	106	161	428	269	191	16
549	.....	.....	274	.....	Present	Present
599	41	76	360	127	75	9
606	25	50	394	83	57	6
539	17	105	153	195	157	17
STRAWBERRIES.						
574	59	104	133	181	19	27
602	36	76	147	124	53	22
CHERRIES.						
921	43	93	461	101	62	8
602	3	38	116	.....	.....	.....
588	28	78	178	132	.....	7
613	Leaking	.....	117	.....	.....	.....
492	Leaking	.....	110	.....	.....	.....
620	16	36	221	57	39	3
634	3	28	105	.....	.....	.....

* Not a swell.

UNIVERSITY OF KANSAS, LAWRENCE.

THE ADULTERATION OF JAMS AND JELLIES.

WALTER S. LONG.

THE KANSAS standards for jams and jellies read as follows:

"Jam, marmalade, is the sound product made from clean, sound, properly matured and prepared fresh fruit and sugar (sucrose), with or without spices or vinegar, by boiling to a pulpy or semisolid consistence, and conforms in name to the fruit or fruits used, and in its preparation not less than forty-five pounds of fruit are used to each fifty-five pounds of sugar.

"Jelly is the sound, semisolid, gelatinous product made by boiling clean, sound, properly matured and prepared fresh fruit with water, concentrating the expressed and strained juice, to which sugar (sucrose) is added, and conforms in name to the fruit or fruits used in its preparation."

Departure from the terms of these standards in one case alone is permitted. Manufacturers may use a glucose product wholly or in part in place of sugar, provided that the product be labeled "glucose jelly" or "glucose jam," as the case may be. The conditions as to the soundness of product, cleanliness, maturity, freshness and preparation of fruit still apply.

Any divergence from the terms of the standards, as in the use of fruit which is not fresh, unclean, unsound, not properly matured or improperly prepared, constitutes adulteration under the provision of the law, which states that "in the case of foods, an article shall be deemed adulterated if any substance has been mixed or packed with it so as to reduce or lower or injuriously affect its quality or strength."

The presence of any foreign substance, such as a preservative or an artificial color, constitutes adulteration, unless the fact that such foreign substances have been added is plainly indicated on the label, and even in that case, if damage or inferiority is concealed, or the product is made to appear better than it really is, the fact of adulteration still obtains. There are on the market products having the appearance of jellies and jams which have for their base a preparation made from inferior portions of fruits, colored in imitation of the fruit. There are others which have for a base preparations made from a cheaper fruit, generally the rejected portions of these cheaper fruits, to which has been added a quantity of a

more expensive fruit, with perhaps a little added color, to give the appearance of genuineness. Such preparations are, as a matter of fact, imitations, and should be labeled as such.

The chief form of adulteration in the past—a form which obtains at present—has been and is the use of apple stock in the manufacture of all kinds of jams and jellies. Apples contain a large number of pectose bodies which favor jellification. A common method of making jellies and jams is the use of an apple stock, consisting of cider, the pressings from apple trimmings, such as cores, skins and rejected portions, or the pressings from rejected apples or from the pomace of cider mills. All these products contain more or less pectin and are used as a common base for the manufacture of jams and jellies of all kinds. Whenever apple stock, even though clean and wholesome, enters into the composition of jams and jellies made from any other fruit than the apple it becomes an adulteration. If the apple stock used is prepared from rejected portions of apples the form of adulteration becomes all the more serious.

As a case in hand, let us consider the following:

A brand of goods on the Kansas market, of which there appears to be a very large quantity, is labeled, without qualification, as follows: "Strawberry preserves." Analysis of the product shows that it contains a trace of starch, that 50 per cent of the ash is phosphate, that the color is partly artificial, and that some product high in bacterial, yeast and mold content has been used. Physical examination shows a gelatinous product containing in suspension portions of strawberries. The conclusion as to the nature of the material used as base for this product may be reached in the following manner:

The trace of starch is not supplied by strawberries or sugar, since neither strawberries nor sugar contain a trace of starch.

The presence of added phosphates indicates that the substance used as a base is deficient in fruit acids, that the acidity of the product had to be increased in order to insure proper thickening in the final product.

The presence of artificial color shows that the manufacturers could not depend upon the natural color of the strawberries used to give the tint desired. Now, as a matter of fact, strawberry preserves require no improvement of their color, nor do they require the addition of acids to insure gelatinization or thickening.

Of all the fruits commonly used in the making of preserves, one alone may contain a small amount of starch, namely, the apple, and the apple may contain it only when in an immature condition. Now, if immature apples had been used as a base there would have been no need of added phosphoric acid or acid phosphate in the product above mentioned, since immature apples contain all that is necessary in the way of acid and pectose bodies required for gelatinization.

The canning factories of the country are the source of a large and cheap supply of apple waste, such as skins, cores, and rejected parts. These contain pectose bodies, are deficient in fruit acids, and contain small amounts of starch and large amounts of bacteria, yeasts and molds. When these are steamed under pressure and subsequently pressed out, a liquid is obtained containing pectose bodies, mineral salts, fruit tissues, a small amount of starch, and large quantities of dead bacteria, yeasts and molds, which on concentration with addition of sugar and phosphoric acid or acid phosphates will yield a respectable-looking jelly. Now if during the process of concentration, or later, some fruit, such as strawberries, fresh or otherwise, and a little coal-tar dye of the right shade be added, the final product will have the appearance at least and a little of the taste at most of a substance known as "strawberry preserves." This product on analysis will show abnormal amounts of phosphates, a trace of starch, artificial color, and large quantities of dead bacteria, yeasts and molds evenly distributed throughout the mass, and the physical appearance will be that of a jelly of pleasing color, holding in suspension the bedraggled remains of what are or perhaps once were beautiful red strawberries. Now in place of strawberries, other fruits or apologies for the same, such as raspberries, red or black, blackberries, cherries, and what not, with the addition of appropriate hues may be used with a corresponding turnout of raspberry preserve, red or black, blackberry preserve, cherry preserve, and what not, all founded upon the very simple, clean, strong, sound sanitary and properly matured and prepared basis above described.

As a further evidence of the conscientious concern of jelly and jam manufacturers for the welfare of the people who subsist in part upon their products, let me speak of the following case:

There is on the Kansas market a very large quantity of material of a certain brand, some of which bears on the label the word "Jelly" and some the word "Jam." Now, the manufacturers of this product, desiring that the purchaser be not mistaken in the nature of his ware, has caused these words to be printed in type so large that the surface of the container is so completely utilized that there is scarcely room for what he has to say besides, and for the splendid painting which he desires his purchaser to receive as a token of his esteem. But being a conscientious man and not willing to deceive the people, he must needs add a few qualifying remarks, and in order to do so is compelled to print these remarks with smaller type, much to his regret, and because these are important remarks. Further, in order that the effect of this painting might be enhanced he has caused the letters of these qualifying remarks to be printed in less conspicuous colors.

The qualifying remarks are many, and as follows:

(*a*) Vegetable color, trace.
(*b*) Added phosphates, trace.
(*c*) Strawberry flavor.
(*d*) Corn sirup, 70 percent.
(*e*) Apple, 30 percent.

Analysis of the product shows that our friend, the manufacturer, in his haste to show his customers a square deal, has made mistakes in several instances at least.

The "trace" of vegetable color happen to be a coal-tar dye and is present in sufficient amount to give to the product what of color it possesses. The "trace" of added phosphates amounts to as much as 50 percent of the mineral matter present. The strawberry flavor happens to be a flavorless flavor. The 30 percent apple, instead of being the fresh, sound, properly matured and prepared whole fruit, as one would naturally expect from a reading of the label and from the reputation of the producer for honesty, is our old friend "apple base." His presence is made manifest by the same old signs: a trace of starch, the necessity of added phosphates, and the multitudes of dead bacteria, yeasts and molds.

Another product put out by the same manufacturer, and of the same brand as the above, is labeled "jam." The same qualifying remarks and the same painting are present on the label, with the one additional remark, "15 percent strawberry."

Analysis of this product shows that the manufacturer has not profited by his former mistakes, but has repeated them all, with one addition—the strawberries have been left out.

These products are adulterated and misbranded. The use of the terms "glucose jelly" or "glucose jam" would only partially remedy the matter. The use of the term "imitation" would more nearly express the whole truth. To express the whole truth, the truth to which the purchaser is entitled, this word should be followed by some such statement as this, "Made from corn sirup, apple trimmings, strawberries and phosphates, and colored with a coal-tar dye."

University of Kansas, Lawrence.

A METHOD FOR THE DETERMINATION OF STARCH.

Walter S. Long.

THE METHODS available for starch determinations may be classified under three heads: Polariscopic, reduction, and colorimetric methods. In all polariscopic and reduction methods starch is hydrolyzed to dextrose, and any method of this kind is subject to the errors involved in hydrolysis and in polarization or reduction, as the case may be. These methods, even when most carefully conducted, are incapable of yielding anything like accurate results. The results invariably come out too low, due on the one hand to the incomplete conversion to dextrose, on the other to overconversion, giving rise to condensation products having a much less or no cupric-reducing power. As to the accuracy of reduction methods it has been shown by various chemists that in calculating starch from dextrose the theoretical value is never obtained, the actual results being from 95 to 98 percent of theory.

Regarding colorimetric methods it is claimed that "while the methods are short and convenient, the results obtained are only roughly approximate." Several methods have been proposed for the direct estimation of starch, such as precipitation with a solution of iodine or barium hydroxide, but none of these methods has yielded trustworthy results.

In working with such products as jams and jellies many samples were found to contain small amounts of starch—too small for satisfactory determinations by any methods avail-

able. It seemed desirable to develop a method, if possible, which would prove sufficiently accurate for such purposes.

The work along this line up to date has been confined to starch solutions, the thought being that any method giving accurate results on such solutions might be made applicable to the estimation of starch in various food products by suitable modifications.

Upon investigation it was found that when equal volumes of a starch solution were treated with equal volumes of iodine solution in the presence of potassium iodide and in amounts greater than the equivalent of the starch present, the latter was completely precipitated, and upon filtering and washing with potassium iodide solution, filtrates were obtained containing equal quantities of iodine. These facts suggested the possibility of a volumetric method similar to that used in the determination of the iodine number of fats. Such a method, however, would obviously involve the removal of the halogenated starch before titration.

A number of trials were made upon starch solutions of different concentrations to determine whether the absorption of iodine was affected by concentration, and also to determine whether duplicate determinations would give concordant results.

Some of the results on duplicate determinations were as follows: For a 1 percent starch solution the titration figures for unabsorbed iodine were 3.35 and 3.20; for a 0.5 percent solution, 8.50 and 8.50; for a 0.1 percent solution, 4.72 and 4.80; and for a 0.05 percent solution, 17.83 and 18.40. These results were sufficient to show this fact—that in the case of any one solution of starch, equal quantities of starch absorb equal quantities of iodine, and further, that unabsorbed iodine could be recovered. The point as to whether concentration has any effect upon the absorption was readily determined by reduction to a common basis of the results obtained for absorbed iodine in the individual cases. It was found that with sufficient care in precipitation and washing of precipitates, especially in the case of the more concentrated solutions of starch, results were obtained which approximate the figures 0.00125, this representing the grams equivalent of starch per 1 cubic centimeter of 1/500 normal iodine solution.

This factor was used in calculating some results obtained by the following method:

To 5 cc. of starch solution in a 100 cc. flask add 5 cc. of a 5 percent solution of potassium iodide and 20 cc. of N/500 solution of iodine (in 5 percent potassium iodide solution). Stopper the flask, shake and let stand over night. Filter off the precipitated starch iodide and wash the precipitate thoroughly with 5 percent potassium iodide solution. Titrate the filtrate and washings with N/500 sodium thiosulphate solution, with the addition of some starch solution as indicator. Run controls using the same amounts of reagents, but omitting the starch.

Some of the results obtained are tabulated as follows:

Starch in Starch Solutions.

Known, percent.	Found, percent.	Difference, percent.	Known, percent.	Found, percent.	Difference, percent.
1.00	1.09	+0.09	0.10	0.11	+0.01
1.00	1.09	+0.09	1.10	0.11	+0.01
0.50	0.42	—0.08	0.10	0.10	0.00
0.50	0.41	—0.09	0.10	0.08	—0.02
0.50	0.48	—0.02	0.10	0.08	—0.02
0.25	0.21	—0.04	0.04	0.031	—0.009
0.25	0.20	—0.05	0.04	0.031	—0.009
0.10	0.14	+0.04	0.068	0.058	—0.010
0.10	0.11	+0.01	0.068	0.062	—0.006
0.10	0.12	+0.02	0.068	0.065	—0.003
0.10	0.11	+0.01			

The applicability of the method to the determination of starch in various food products has not yet been determined.

University of Kansas, Lawrence.

A METHOD FOR THE QUANTITATIVE DETERMINATION OF SALICYLIC ACID IN THE PRESENCE OF ACETYL SALICYLIC ACID.

G. N. Watson.

DURING the past few months both state and federal laboratories have found many adulterated samples of acetyl salicylic acid (asperin), one of the most common adulterants of this product being salicylic acid.

Among the qualitative tests for the differentiation of acetyl salicylic acid and salicylic acid is the test with bromine water. Bromine water gives a precipitate with salicylic acid, but does not give a precipitate with acetyl salicylic acid.[1] This fact and the method of Fr. Freyer[2] for determination of salicylic acid by means of a N/10 bromine solution were utilized for the quantitative determination of salicylic acid in mixtures of the two drugs. The method of Freyer is practically that of the U. S. P. for the determination of phenol. The end product, tri-brom-phenol, is the same with both drugs.

Two solutions were prepared, one containing 100 mg. of salicylic acid in 100 cc., and the other 100 mg salicylic acid and 100 mg. acetyl salicylic acid in 100 cc. Ten cc. of the solution, equivalent to 10 mg. of U. S. P. salicylic acid, were used for a determination. Twenty cc. of N/10 bromine, U. S. P., were added, followed by 75 cc. water and 5 cc. hydrochloric acid. The mixture was allowed to stand, with occasional shaking, in a glass-stoppered flask for ten minutes, when 5 cc. of potassium iodide, T. S., were added, and the liberated iodines titrated with N/10 sodium thiosulphate, V. S. The two solutions required the same number of cc. of N/10 thiosulphate and showed the presence of 9.9881 mg. of salicylic acid in 10 cc. samples of each solution.

A 50 mg. sample of the same salicylic acid showed, by direct titration with N/10 KOH, a purity of 99.9 percent, which result checks very closely with the preceding.

It must be remembered, however, that a cold aqueous solution of acetyl salicylic acid decomposes slowly, forming salicylic acid, and if heated the reaction is comparatively rapid.

1. Fuller, Qualitative Analysis of Medicinal Preparations, p. 26.
2. Chem. Zeitung, vol. 20, p. 820.

Therefore, determinations must be made at not above room temperature and soon after bringing the samples into solution. To illustrate: 10 cc. of the above mixture of salicylic acid and acetyl salicylic acid showed, after standing forty-eight hours, 11.53 mg. of salicylic acid, or an increase of 1.542 mg. during that length of time.

Six atoms of bromine correspond to one molecule of salicylic acid, or 1 cc. of the N/10 bromine consumed is equivalent to 0.002283 gm. of salicylic acid.

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SOME CHEMICAL PRODUCTS OF PHYSICAL FATIGUE AND THEIR POSSIBLE EFFECT ON MENTAL EFFICIENCY.

(Abstract.)

F. C. Dockeray.

In an article recently published in the Kansas University Science Bulletin I have briefly reviewed the investigations concerning the chemical products of physical fatigue. Lactic acid, potassium salts and carbon dioxide have been shown by investigators to be closely associated with decreased physical activity. Injection of lactic acid, for example, into an isolated muscle or into a normal rat produces the same effect that continued contraction or work would do.

But a small amount of lactic acid does not have an effect proportionate to a larger amount. On the contrary, a low concentration of lactic acid, or potassium salts, produces increased activity in the rat, and an isolated muscle shows a like augmenting effect by an increase in the height of the work curve. As the concentration is increased the augmenting effect is replaced by decreased activity.

In the investigation of the relation of physical fatigue to mental efficiency, cited above, I have found similar phenomena. A moderate amount of physical fatigue is followed by increased mental ability, as evidenced by memory and attention tests. Following greater physical fatigue, mental fatigue decreases, if not immediately then soon after rest begins. It may be assumed that these results are due either to the distraction effects of the sensations of fatigue or to the presence of one or more of the fatigue products in varying degrees.

More recent experiments, as yet unfinished, bearing upon the former theory seem to indicate that these effects can not be entirely ascribed to distractions. The latter theory offers an opportunity for further research.

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ECHINACEA: ITS COMBINATION AND USE.

J. M. McWHARF, M. D.

ECHINACEA ANGUSTIFOLIA, DeCandolle, is recognized by three common names, narrow-leafed purple cone flower, purple cone flower, and black sampson. This plant is herbaceous and has a thick, black, pungent root. It sends up annually a stem that may be either slender or stout. This condition doubtless is due to its envorinment. These stems are from two to three feet in height and are covered with hair. This plant is not found east of Illinois. We have a plant growing in the eastern states known as *Echinacea purpurea*, and called by some black sampson. This has produced confusion. Its therapeutic value is slight. *Echinacea angustifolia* is an entirely different plant, found only in prairie states, mostly in the hills of Kansas, where it is indigenous. It is most plentiful in the sand hills of Kansas. The medicinal properties of this plant was first brought to notice in 1885. During the ten years following and up to 1895 it had been prescribed for all manner of diseases. Since 1895 care in the study of the properties of the plant has prevailed and more accurate conclusions reached as to its medicinal virtues, which as yet have not been fully established.

V. von Unruh after years of laboratory work has succeeded in giving this drug a scientific place. He says:

"Echinacea in its physiological action produces a feeling of intoxication, flashes of heat, headache of a dull character, dull muscular pains, subnormal pulse, cold and numb extremities, and an increase in the specific gravity of the urine. These symptoms pass off gradually within several hours, showing that the drug has no continuing toxic nor detrimental effects. Death from overdoses have never occurred. In therapeutic action it directly stimulates the flow of saliva, sweat and urine. It increases glandular activity, thus antagonizing all septic poisons, aids elimination of toxins, and acts as a destructive upon the streptococci, staphylococci and other pyogenic organisms. Echinacea increases the phagocytic power of the leucocytes; that is, the leucocytes are increased in activity. Injection of from 3 to 5 cc. in cases that showed an abundance of cocci and pus gave results showing a speedy decrease of cocci and pus cells. Hyperleukocytosis and lucopenia are directly improved by echinacea. The proportion of white to red cells is rendered normal."

In tests made by myself in septic cases it has never disappointed me. I do not hesitate in stating that it is the one

remedy above all others in the treatment of septic infection. This statement applies to the single drug echinacea. I have used in the same cases, but to a less extent, a formula called ectisia. This contains *Echinacea, Baptisia, Thuja,* and *Phytolacca.* This combination is very suggestive and may prove of greater value than the Echinacea alone. Its range of application may be greater. Its advocates claim great things for it; that the echinacea in the compound is materially increased in its effects. Keep the one thought before your mind, viz: Echinacea stands first as a corrector of dyscrasia. It is an intestinal antiseptic and of rare value in typhoid fever, the course of the disease made shorter and the danger, to a degree, eliminated.

I doubt if it has an equal; at least no superior. It may be used as a local application and as a remedy for internal administration. Judiciously used, it acts as a stimulant against tissue waste. The entire lymphatic system feels its influence. As a remedy for blood poison it is a specific if there be one in the materia medica. Five tabulated indications for the use of *Echinacea* or echtisia, are given below:

1. As a remedy for rattlesnake bites and the poison of other venomous reptiles, and the sting of bees, wasps and other poisonous insects.

2. As a remedy in puerperalsepsis and all other forms of septic infection, including those classed under the general head of blood poisoning.

3. In the treatment of boils, carbuncles, abscesses and other like conditions.

4. As an intestinal antiseptic, especially in zymotic diseases, as typhoid fever, pneumonia, etc.

5. As an alterative or blood purifier in cases of slow, progressive blood taint from defective elimination.

Ottawa.

STRAMONIUM.

L. D. Havenhill.

SOME time ago my attention was called to the fact that enormous quantities of stramonium are found growing throughout the United States, seemingly for no other purpose than to furnish shade for hogs and hens and to perhaps now and then poison a cow or two.

As this plant is a valuable one medicinally, the question naturally arose, Why does our supply of it as a drug come from Europe?

Since drugs grown under different climatic conditions are known to vary considerably in therapeutic activity, it was thought that this might account for it and that the American-grown drug was not of sufficient value medicinally.

Reference to the analyses of over 100 lots of leaves of this plant, imported from Europe, showed a range from 0.20 per-cent to 0.57 percent of mydriatic alkaloids, with a mean close to the present pharmacopœial requirement of 0.35 percent.

A quantity of stramonium leaves that were collected by me from plants growing in a hog lot in Kendall county, Illinois, in the fall of 1911, yielded 0.46 percent of mydriatic alkaloids by the pharmacopœial method of assay.

In the latter part of September, 1914, I collected a quantity of stramonium leaves from plants growing in a barnyard on the south slope of Blue mound, near Lawrence, Kan. It will be remembered that that season was a very dry one. The plants were past flowering and the capsules were well developed. The leaves were small and somewhat withered and in some cases beginning to fall. These leaves were spread out and dried in a warm attic. This sample, when analyzed, was found to contain 16.8 percent of ash and 0.213 percent of alkaloids, both calculated to a basis of moisture-free drug. The yield of alkaloids in this sample was below the pharmacopœial requirement. It is thought that the age of the plants, together with their exposure to heat and drought, might account for the low alkaloidal content.

Later that same year, October 26, some stramonium was found growing in a potato patch in the 1,000 block on Illinois street in the city of Lawrence. These plants had evidently

come up after the cultivation of the potatoes had ceased. They were therefore younger than those furnishing the former sample and had not withstood the dry summer. The ground was soft; moisture seemed to be near the surface, and the plants appeared to be fresh and healthy. They ranged in height from 10 inches to 2½ feet. The small plants had not yet budded; the older ones were beginning to fruit, but had not passed the blossoming stage. About 50 pounds of herb were collected and separated into two lots, one of young plants and the other of mature plants. Each of these lots was divided into two nearly equal parts. From one part of each lot the leaves were removed from the stems before drying. The other part of each lot was dried before removing the leaves.

The drying was carried on in a warm room at a temperature not much above 30° C. The ash determinations were made on the air-dry sample as well as the alkaloidal assays, but both results were calculated to a moisture-free basis. The leaves from the older plants lost 85.5 percent and those from the younger plants 88 percent on total drying. The assays did not indicate any difference in the alkaloid contents of the leaves that were separated from the stems before drying and those that were not.

The leaves from the small plants contained 0.446 percent of alkaloids and 19.8 percent of ash. The stems from the small plants assayed 0.300 percent of alkaloids. The leaves from the older plants assayed 0.377 percent of alkaloids and contained 17.7 percent of ash. The stems from the older plants contained 0.080 percent of alkaloids and 7.8 percent of ash.

A part of the leaves in one of the lots from the older plants was not turned often enough and began to mold. This part of the drug was kept separate, and after drying was found to contain 0.365 percent of alkaloids and 23.5 percent of ash. This would seem to indicate that the alkaloid in the leaf was quite as resistant to the action of fungus as the cellular tissue of the leaf.

These assays do not agree with those of Dr. A. R. L. Dohme, who in 1893, when working with a sample grown in the vicinity of Baltimore, Md., found that the stems contained a larger percentage of alkaloids. (A. J. P., vol. 65, p. 479.)

F. A. Miller and J. W. Meader, of the firm of Eli Lilly & Co., of Indianapolis, in 1913 report (Jr. Ind. Eng. Chem. vol. 5,

p. 1014) the analyses of some native leaves grown under cultivation which ranged from 0.420 percent to 0.710 percent of alkaloids. These latter assays would seem to indicate that this plant, which apparently thrives in this country in places where nothing else will grow, may with care and cultivation be made to produce a drug much superior to that which is imported from Europe.

From the data available it is evident that the American-grown stramonium is equal if not superior to that grown in Europe, and that if we continue to import this drug it is not because of the superior product that we receive but because of the economic conditions that exist in this country.

UNIVERSITY OF KANSAS, LAWRENCE.

ANALYSIS AND COMPARATIVE HEATING VALUES OF NATURAL GAS AND COALS.

H. C. ALLEN.

IN VIEW of the recent publicity given the natural-gas question in this part of the country, the following data, prepared for the Public Utilities Commission of Kansas and used with their consent, is believed to be of considerable general interest. The coals given are typical of those sold in the territory supplied with natural gas, and the samples used were fairly representative, with the exception of the Leavenworth sample, which was rather more of a selected sample. The matter of efficiency, cleanliness, convenience, and all personal factors are not taken into account in the figures given, only the actual total number of heat units obtained being considered. The prices per ton given for the coals are those that prevailed in Lawrence at the time the tests were made.

Lawrence, city supply of natural gas.

Lab. No	1238	1249	1250	1260	1261
Date, 1916	10–7	10–15	10–16	10–17	10–18
Analyses:					
Carbon dioxide	0.23%	0.77%	0.85%	0.51%	0.72%
Oxygen	0.00	0.00	0.45	0.55	0.17
Methane	85.80	88.44	89.95	91.24	92.50
Ethane	7.22	5.74	4.97	3.52	3.11
Residue	6.75	5.05	3.98	4.18	3.50
Total	100.00%	100.00%	100.00%	100.00%	100.00%

Heating value, calculated to 0° C. and 760 mm. pressure, B. t. u.

Gross	1,048	1,049	1,050	1,037	1,043
Net	953	954	954	942	948

Average gross heating value, corrected for humidity and to 60° F. and 30 in., 993 British thermal units (B. t. u.).

Coals.

Lab. No	1251	1252	1253	1254
Kind of coal	Ark. Semi-anth.	Burlingame	Briquette	Cherokee
Price per ton	$7.50	$5.00	$7.50	$5.00
Proximate analysis:				
Water	0.45%	7.67%	0.56%	1.81%
Volatile	18.07	39.62	21.21	36.11
Fixed Carbon	73.48	38.44	63.88	52.35
Ash	8.00	14.27	14.35	9.73
Total	100.00%	100.00%	100.00%	100.00%
Heating value per pound, B. t. u.	14,133	10,972	13,061	13,341
Comparative price of gas in cents per 1,000 cubic feet	26.35	22.58	28.51	18.61

Lab. No	1255	1256	1257	1258
Kind of coal	Ark. Anth.	Smithing	Leavenworth	Ill. coal
Price per ton	$9.00	$10.00	$4.75	$6.00
Proximate analysis:				
Water	1.45%	0.58%	5.95%	7.76%
Volatile	15.25	22.42	39.15	43.60
Fixed carbon	75.36	70.08	48.11	43.00
Ash	7.94	6.92	6.79	5.64
Total	100.00%	100.00%	100.00%	100.00%
Heating value per pound, B. t. u	13,560	14,339	12,718	12,375
Comparative price of gas in cents per 1,000 cubic feet	32.95	26.61	18.54	24.07

HISTORY OF KAW LAKE.

J. E. Todd.

EIGHTEEN years ago Mr. B. B. Smyth read a paper before the Academy, on "The Buried Moraine of the Shunganunga." In it he sketched several glacial lakes which skirted the edge of the Kansan ice sheet. Among these he outlined one which he called Kaw Lake. The writer has studied it as one of the interesting chapters in the Pleistocene history of Kansas.

DATA ASCERTAINED.

Let us first notice the significant facts so far as they have yet been recognized; then offer a theoretical explanation of them, and finally weave them into a consistent history.

1. *The Basin.*

When riding westward on the Union Pacific one loses sight of bluffs containing limestone edges on the north side, a little west of St. Marys. He fails to see any high ones again till he comes upon them abruptly at Manhattan. There he passes through a comparatively narrow gateway in a high, stony ridge which runs northward along the west side of the Big Blue and on the south swings eastward on the south side of the Kansas river.

East of the Blue the escarpment of higher hills leaves that stream four or five miles north of Manhattan and trends E. N. E. to the valley of Rock creek, and passing four or five miles north of Louisville, curves more south to the vicinity of St. Marys, as before stated. This rim rises frequently over 1,200 feet A. T. or 200 feet above the river, on the north, while on the south it rises to 1,400 feet in a few miles, particularly toward the west.

Within the limits given, no point rises more than about 1,150 feet, and while limestone ledges are seen between Wamego and St. George, they are low and are deeply covered with sand and loamy clay, especially on the west.

2. *The Configuration of the Carboniferous Bedrock Below.*

The upper limit of the Pennsylvanian shales and thin limestones lies at three levels, the lowest, underneath the channel and flood plain of the Kansas river, is from forty to sixty feet

below the surface, variation being according to the inequalities of the surface and the hardness of the underlying rock.

The next level is a little higher than the flood plain near St. George, and marks the lower limit of erosion of the larger streams previous to the formation of the lake. It corresponds to the limits of such valleys. One of those valleys seems to have come south from Rock creek to St. George, another from the Big Blue northwest, and a third from the direction of Manhattan.

Mr. Oscar Talbot, who has drilled numerous wells in that region, says that the main supply of water is found in a few feet of gravel, which on the divide south of Rock creek is 160 feet below the surface. He refers the springs west of St. George, including one piped into town, to this source.

The third and highest level is between Wamego and St. George, lying east of the old Rock creek channel mentioned above. Its general height above the river south is 120 to 159 feet, with some points probably a little higher west of Wamego. Its lower portions seem to correspond to the bottom of a channel and the higher points to parts of the banks.

On the southeast flank of this higher portion, about a mile southwest of Wamego, there is a clear exposure of the second level, and at Wamego the lowest level underlies the town, while an intermediate level between the two and corresponding to a narrow silt terrace, rising 35 to 40 feet higher, is indicated by wells.

3. *Bowlders.*

Red quartzite bowlders, similar to ledges in southwestern Minnesota, with occasional bowlders of gray granite and greenstone, may be met with throughout the basin, particularly on higher points, but with the following limitations:

(1) They are more abundant in a belt one to two miles wide, extending in a S. S. E. direction from the forks of Rock creek, passing two miles west of Wamego. Along this belt they are more abundant in patches. As they rest on sand and clay, erosion has caused them to stand out on knolls in such a way as to simulate quite closely morainic hills. Further west they are less numerous, and are usually found resting on the surface of the Carboniferous bedrock. They are often deeply covered with lacustrine clay.

(2) They seem to be limited to areas below 1,150 feet A. T. This is true particularly on the south and west sides of the basin. The bluffs to the north and east of the Big Blue and north of the basin show them at much higher levels. South of the Kansas, also, bowlders are very abundant and are often of large size, in a continuation of the bowlder belt before mentioned. They rise above 1,200 feet A. T. and are sharply limited on the southwest by an old valley extending along the line of the east branch of Antelope creek and Paw Paw creek to Mill creek. West of that valley and south of the Kansas they are not found, except in the valley of Deep creek and below the old lake surface, 1,150 A. T.

(3) They are scattered in the bottom and sides of an old channel, which runs underneath the Agricultural College grounds and north to the Big Blue. There they are deeply covered with loesslike silt. They have not been found higher than the old lake level, not occurring on the hill on which the city reservoir stands. I have been informed that some have been found about nine miles southwest of Manhattan, but have been unable to verify the statement. Mr. Robert Hay states that a few were found as far west as Fort Riley.

(4) In the valley across the divide between Kansas river and Mill creek, as has already been implied, they are very abundant. The bottom of the old valley where exposed by erosion is literally paved with medium-sized bowlders, one to three feet in diameter.

(5) A somewhat similar valley nearly parallel with it, leading from Antelope to Pretty creek, a tributary of Mill creek, although 50 to 75 feet lower than the one just mentioned, has no northern bowlders in it, except toward the southern end, where it approaches the other valley. This lower valley shows signs of recent active erosion. It affords the easiest route for the railroad to traverse the high divide.

4. *Sand and Silt.*

We should speak more explicitly of the distribution of the sands and clays to which we have repeatedly referred. Between the Union Pacific railway, which follows the river, and the high bluffs which form the north rim of the old lake basin are deep deposits of sand below and a loesslike silt above. The sand is more conspicuous on the surface just west of the bowldery belt. This may be in part due to the wind raising it

from the creek valleys. Some low dunes probably rise higher than the former lake level, upon the higher Carboniferous platform west of Wamego. From these elevations and the comparatively flat divide south of Rock creek the upland surface declines gently to the southwest. The bluffs bordering the river flood plain are over a hundred feet above the plain at St. George, and but little lower near the Big Blue near St. Patrick's church.

A yellow clayey silt fills the bowldery channel north of Manhattan. A similar deposit rises as a terrace north of Ogden, which may be the old delta of Seven Mile creek. Its base is sandy and its summit is 70 to 80 feet above the river.

Another deposit very similar occurs near Fort Riley. It was called loess by Robert Hay.

5. *Chert Gravels.*

These constitute a very interesting feature of eastern Kansas. Along all the streams flowing eastward from the cherty strata of the Permian there are conspicuous terraces capped with chert gravel. They are noticeable at Alma, Paxico and other similar locations. They are usually on the north side of the streams.

Such a stratum has been observed at several points in the basin of Kaw Lake. It varies in thickness and purity, and also considerably in altitude. It is found in the bottom of the ancient channel north of Manhattan, about 100 feet above the Big Blue. It is found a mile southwest of Mt. Zion church at about the same altitude.

Northeast of St. George it is about 150 feet above the river south. On the top of the Carboniferous bluffs between St. George and Wamego and extending north of the latter place, it is 100 to 120 feet above the river south. The difference in altitude may correspond to the differences in altitude between the bottom of the channel and the banks, and possibly low terraces.

South of the Kansas river it has not been found in the basin, except southwest of Wabaunsee, east of Deep creek, and about 135 feet above that stream.

In all these localities red quartzite bowlders occur, lying on the chert, but never in it.

Along Pretty creek a little outside of the basin the chert stratum has been traced at the proper level to connect with

the terrace along Mill creek; moreover, it is there also sprinkled with northern bowlders.

6. *No Distinct Trace of Glacial Action.*

Another fact of significance is that no distinct trace of glacial action has yet been found in the basin of Kaw Lake. No striated ledges and no unmistakable till has been discovered. This may be explained by the supposition that deep deposit had formed before the ice sheet reached this locality. The underlying rocks were well covered. The absence of till would be accounted for by the same conditions. The ice would rest on lacustrine beds, but had little molding effect because of flotation by the waters of the lake.

ACCEPTED CONCLUSIONS.

These are the most significant facts. How may we account for them and weave the interpretation into a consistent history?

1. *The Age and Deposition of the Chert Gravels.*

As has already been hinted, the chert has every appearance of having been deposited in a river, and its derivation from the abundant cherty limestones of the Permian which cap the higher points about Manhattan and westward is quite obvious. It was evidently deposited before glaciers had come near enough to bring their contribution of northern material, for no northern erratic has yet been found intermingled with the gravel, when in its original position. Further east, near St. Marys and Topeka, where they have been rearranged at lower levels, there has been an intermingling. Still further east, northeast of Lawrence, where they are again found at an altitude of 125 to 150 feet above the Kansas, they are again distinctly separate. Their deposition must have been before the Kansas flowed through south of Manhattan, and before that channel and the one from Rock creek had been deepened as has been noted about St. George. This is attested by the old channel north of Manhattan, which shows the chert gravel, and on a level corresponding to that near Wamego. It seems, therefore, that the chert gravels may be as old as the Pliocene. It has been hoped that fossils might appear which might decide their age, but such have not yet been found.

2. *The Age and Cause of the Buried Channels West and North of St. George.*

The result of the last season's investigation has been the assurance that the channels north and west of St. George were eroded earlier than had been formerly thought. The former view had been that the somewhat lower surface west of St. George was really a terrace formed after the recession of the Kansan ice sheet, but it is now evident that the deep erosion preceded the damming of the Kansas by the ice. Stratified deposits are found to be continuous from the level of St. George up to the level of the divide separating from Rock creek. Moreover, northern bowlders are found to the bottom of the series as exposed near St. George, and well drillers report striking them down to a corresponding depth. This shows that before the lake was filled the Kansas river had cut down the bottom of its channel to within 20 or 30 feet of the present surface of that stream, or within 60 to 80 feet of the bottom of the alluvium in the trough of the present stream. From this it may reasonably be inferred that the drainage level had been lowered 70 or 80 feet from the time of the chert gravels, or about half way from the latter to the present level.

Of course this new view will require a rearrangement of conclusions all along the line. If the general drainage level had been lowered at St. George there must have been a corresponding lowering at Topeka, Lawrence and Kansas City. The erosion underneath the terrace at Cameron's bluff and Lawrence would have been before the maximum advance of the Kansan ice, not after it. And the occurrence of bowlder clay low down at Kansas City, Kan., is easily explained, which in the earlier view had been quite a puzzle.

The channel north of Manhattan was not cut down because the Kansas had broken through eastward, south of that place. The chert gravel was also left intact at other points because of the lateral shifting of the streams as they cut down.

What could have been the cause of the general drainage after it had remained so long at the chert-gravel level?

It could have hardly have been due to a differential elevation of the region, for there seems to be close parallelism between the older and later drainage levels, or slopes. Possibly there has been a general elevation. In fact, it is quite probable that there has been considerable elevation since the ice retreated,

and it may have begun before the ice advanced. Possibly some of the down-cutting may have preceded the influence of the ice, but the more plausible explanation of the facts may be ascribed to the flooding of streams from the melting of the ice sheet as it advanced from the north. The first to enter the basin of Kaw Lake, we figure, was from the Big Blue, and when the ice front had reached Pawnee county, Nebraska, or later, the northern part of Nemaha county, Kansas, Rock creek would have begun its share of the work when the ice had reached northern Pottawatomie county, twenty-five miles away. It may be that Vermilion river may have come into the basin and begun similar work at a considerable earlier date, but we have no evidence of it. Meanwhile tributaries of the Kansas further east would have caused similar erosion of the trough of Kansas river further east, in its lower course, so that before the ice had reached its valley we may believe that the down-cutting may have been going on quite rapidly. Velocity of the ice and rapidity of melting would have accelerated erosion, and the length of time it took for the ice to advance from the divide to the channel of the river would determine the amount of excavation.

3. *The Formation of Kaw Lake.*

We do not know the rate at which the ice advanced nor what fluctuations it experienced, but we have found no trace of its edge pausing anywhere long enough to form a distinct moraine, or rows of drumlins.

We judge, from the distribution of bowlders, that when at the maximum extent the edge of the ice lay from the junction of Camp and Rock creeks southeast across the river and over the divide south into the valley of Mill creek, and thence eastward, with its southern edge five to ten miles south of the river, and recrossing to the north side near Lecompton.

The evidence for this is the abundance of bowlders scattered north of that line on higher points, and traces of bowlder-strewn channels leading away south of that line, according to topography. It has not been fully explored, only from Lawrence to Dover, and from Paxico to McFarland.

The Kansas valley was not so deep as now, by 75 or 80 feet. We can imagine that the river struggled with the ice for the possession of its channel, probably forming rapids and erod-

ing actively its southern bank; perhaps for a time melting tunnels under the ice for some distance. But eventually the ice held undisputed possession and the river was completely dammed, and the water above the ice steadily rose, and we may believe quite rapidly, for the drainage of the whole western edge of the ice contributed to it.

4. *Why the Outlet Was by Paw Paw Creek Rather Than by Pretty Creek.*

Comparing the successive courses of the Kansas, it will be seen that on the whole there has been a steady shifting of the stream toward the south, hence the south side of the old lake basin was considerably further north. This is attested by the absence of bowlders south of the river remote from the ice, except in the old valley of Deep creek. This means that the valley occupied by the railroad, and lower than the old outlet by more than 50 feet, is the work of more recent erosion. A study of the junction of Antelope creek with its tributary from the southeast, near Pavilion station, favors the conclusion that the upper portion of Antelope creek formerly belonged to Pretty creek, and that a divide separated it from the valley of the Kansas. This divide was high enough in the time of Kaw Lake to prevent any escape of water except by the Paw Paw outlet. It should be remembered in this connection that below the limestones, which rise one above another to the west and southwest of the basin, there lies 300 feet of shales, which permit of rapid erosion.

5. *The Filling of the Lake.*

The lacustrine deposits of the lake came mainly from the ice sheet, which both formed the lake and furnished it sediment. When the lake first overflowed and the ice was at its maximum, the latter was probably several hundred feet thick in the river valley. It probably shed small bergs occasionally, carrying debris, including bowlders. Vigorous streams from under the ice doubtless brought much sand and silt. The larger of these, Rock and Camp creeks, brought material from the ice further north. The Big Blue doubtless brought a generous contribution from still further north. The edge of the ice is known to have lain about Blaine some 300 feet higher than the level of the lake; therefore, there were rapid streams bringing much to the Blue, not only from the northern part of

this state, but from Nebraska, and possibly from Dakota, for at that time we may suppose that the surplus drainage of all the western edge of the ice sheet and of the eastern slope of the Rockies may have come through the Big Blue. We can believe that it built up quite a delta where it entered the lake, which has since been mainly removed. The filling of the channel north of Manhattan may be considered a portion of it which has been preserved by its position.

The lacustrine deposits are coarser below, even carrying pebbles and a few bowlders near the bottom, but fine silt resembling loess above. The sand is thicker toward the east, and some of it whipped out of stream channels covers much of the surface, including the highest points northeast of St. George. Further west the surface is more clayey.

6. *The Reopening of the Kansas Channel.*

Little need be said of this. The melting of the ice, as the Kansan glacier finally withdrew, probably left the channel much as it was when the ice came. The ice did not last long enough, probably, to bring much till into it. Thus far, at least, none has been discovered, though it is not improbable that some may be found in time. It is probable that when the Kansas first retraced its old course that it lowered the level of Kaw Lake quite rapidly; that the stream was rapid and vigorous and loaded with coarse material from the adjacent ice sheet. As the amount of water declined there was a stage of rapid aggradation which filled the valley lower down. The thick river deposits in the terrace northwest of Lawrence, back of Cameron's bluff, may be referred to this stage.

7. *The Formation of the Lower River Terrace.*

Reference has been made to a silt-capped terrace west and north of Wamego. It doubtless was formed since the draining of the lake and marks a stage in the history of the river since its reopening. Wells show that the bedrock underneath is not as deep as under the present flood plain. Trace of the same terrace may be seen south of the river below Antelope creek, and above and below Wells creek. Without doubt, study will find out other fragments of it, and it may possibly be correlated with the terrace at Kansas City, which is there over 100 feet above the river. Here it is only 40 to 60 feet higher.

SKETCH OF THE HISTORY.

The history may be briefly summed up as follows:

In the late Tertiary the Kansas river followed a course approximating that shown in map 2. Its volume and gradient may have been less than now.

Following that was the initiation of the continental ice sheet, with a probable gradual elevation of the western Great Plains. In the long interval in which the ice was accumulating in the north and advancing enough to affect this region directly, there may have been an increase of precipitation here which would have quickened stream erosion.

In time the ice began to creep over the northeastern divide. The Big Blue and the Kansas below their junction had their volume materially increased. Later Rock and Camp creeks were also swollen, and together they deepened and broadened the channels in map 3.

This stage was finally ended by the damming of the river by the ice and the filling of Kaw Lake as shown in map 4. The lake may have lasted a few hundred years.

The streams already mentioned, with increased vigor, built up deltas in the lake, while streams directly from the ice contributed perhaps even more. Small icebergs from the glacier, helped somewhat by river ice, scattered bowlders over most of the lake. Their numbers would be inversely as the distance from the edge of the ice sheet.

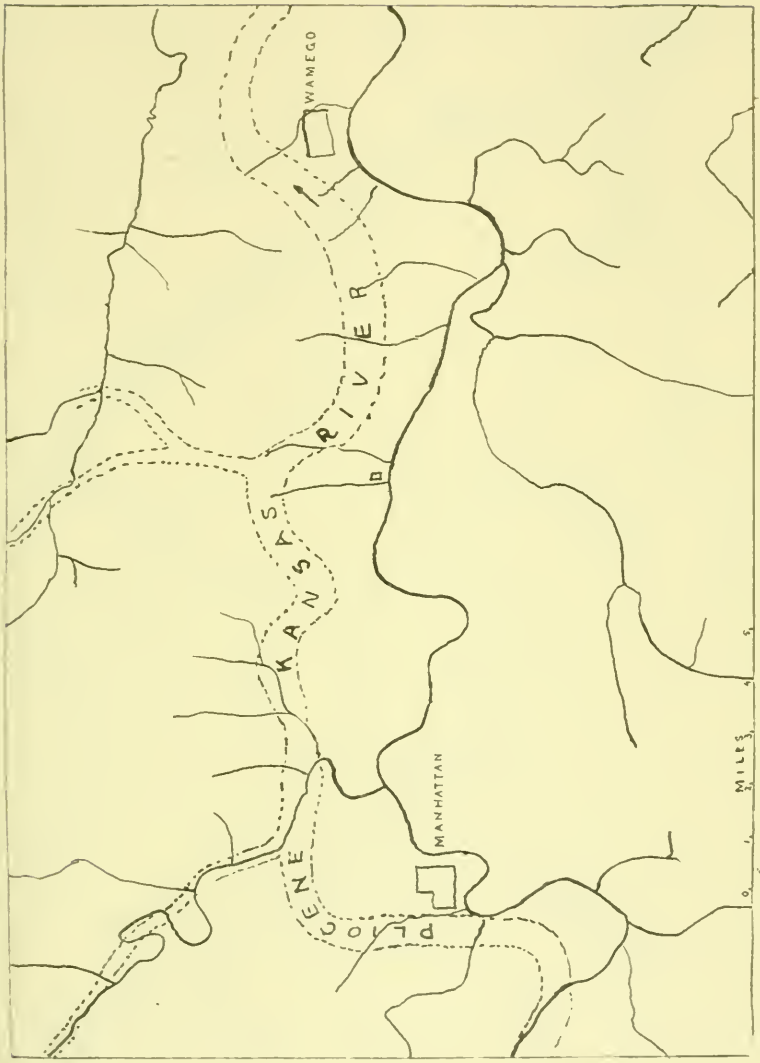
The bowlders lining the outlet may have come, a very few of them, from the lake, but most of them from the edge of the ice close along its northeastern side.

When, by the retirement of the ice, the lake disappeared, the river found its former channel much the same as before, and itself for a time much larger.

As the ice receded and dwindled the streams diminished to their present proportions and gradually cut down to their present level.

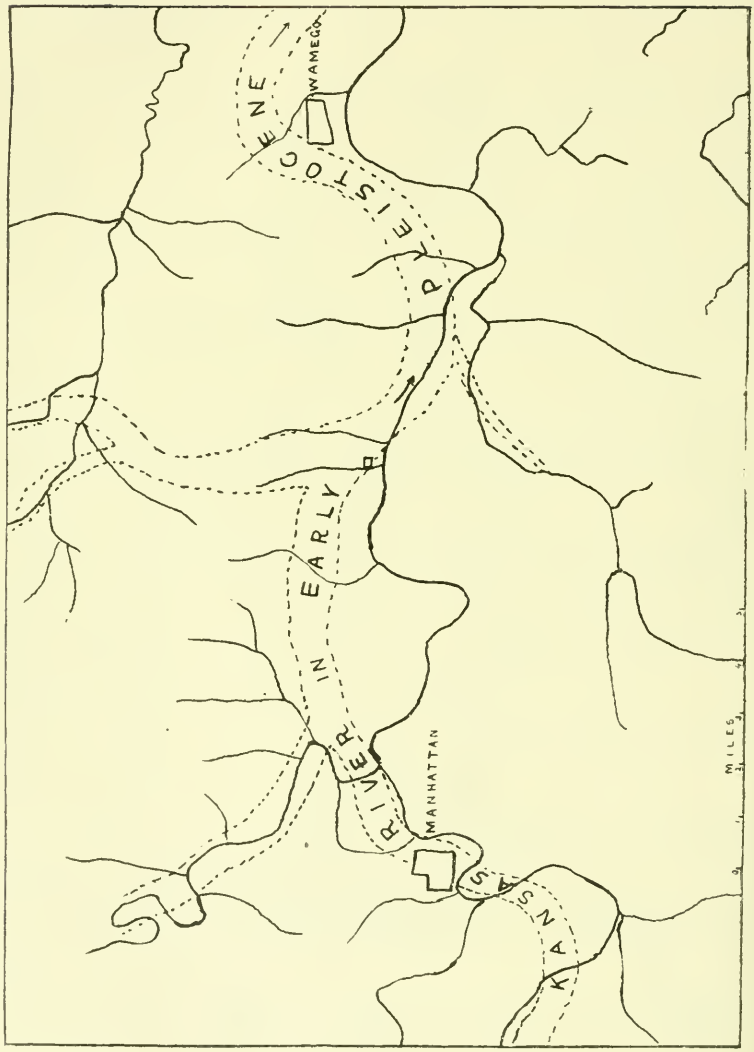
The terrace may mark a flooded stage corresponding to the close of the Wisconsin stage of the ice age.

University of Kansas, Lawrence.



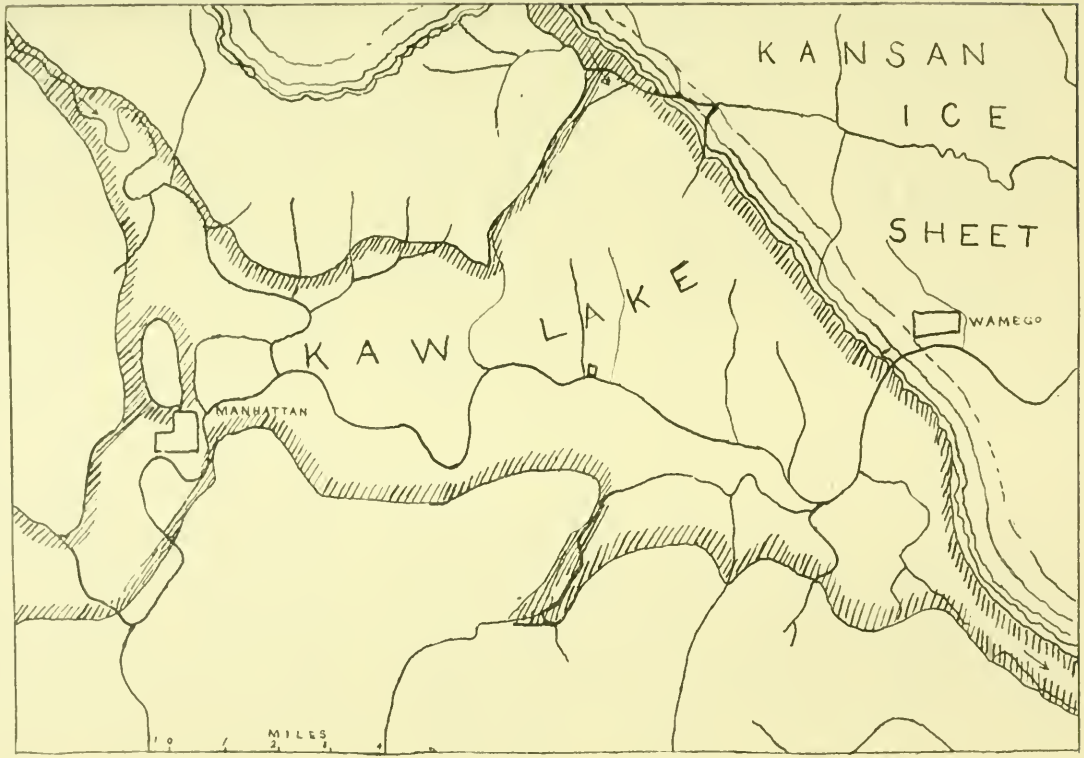
MAP 2.

Pliocene course of Kansas river.



Early Pleistocene course of the Kansas river.

Map 3.



Maximum of the Kansas ice sheet, Pleistocene.

EOLIAN LOESS.

J. E. Todd.

OF LATE YEARS numerous writers have supported the view that the mass of the yellow loam of the Missouri and Mississippi river valleys is of eolian origin. Some textbooks define loess as an eolian deposit without qualification. While the writer cannot harmonize this extreme view with the facts known to him, he would enumerate several cases which are unquestionably the work of the wind.

He would first call attention to the conditions productive of sand dunes in certain localities; secondly, show that the accumulation of dust is often to be explained in similar ways; thirdly, note one locality which can be explained in no other way; and fourthly, explain the *modus operandi* of such deposits generally.

1. South of the Platte river, near Kearney, Neb., is a strip of conspicuous dunes crowning the bluffs and rising above the upland level further south. The sand apparently has been raised by the northwest wind from the river channel just north. Moreover, the greater accumulation there may be accounted for by the fact that the river above this point has a southeasterly course for several miles and there changes to due east.

2. Another cluster of dunes, rising above the general level around, occurs east of West Point, Neb., where the Elkhorn changes sharply from a long southeasterly course to a southerly. In both of these cases the northwest wind is considered particularly instrumental, because it prevails at a time when the river is low, the bars extensively uncovered and the vegetation elsewhere scanty.

3. We now call attention to accumulations of finer material —in other words, loess—in analogous situations along the Missouri river. In these cases there is very little sand available, and only of a fine grain, and the bluffs are much higher than those already considered. The general course of the river is south-southeast from Sioux City to northern Missouri. The bottom lands on the east of the river are in places very wide. These occur where soft rocks lie at the level of the river. On the contrary, where harder strata at that level have

resisted the erosion of the stream, the valley is narrow and as a consequence high bluffs rise conspicuously on the east side of the valley just south of the wide areas first mentioned. Because of the relations described above, such projections of the east bluffs are apt to grow in height till they rise considerably above the upland level further east.

A typical case of this sort is found four or five miles south of Pacific Junction, in southwestern Mills county, Iowa.

Another is north of Council Bluffs and south of Crescent City, and another lies east of the Little Sioux, in southern Monona county. The gathering ground for this last was a bottom land twelve to fifteen miles wide; consequently the bluffs are unusually high.

4. A somewhat different case is found in southern Plymouth county, east of the Big Sioux river, and of a broad bottom land between that stream and the Missouri further west, and of the bend in the latter stream, where it changes from an easterly direction to the south-southeast.

Dr. H. F. Bain, in his report on Plymouth county, called attention to the peculiarities of this area. (Iowa Geol. Rept., vol. viii, p. 322.) The region shows the divides rising 250 to 300 above the streams and 60 to 100 above the upland level on the east and north. This extra height seems to be due to recent deposition over the whole surface. The valleys are so narrowed that the streams can barely keep their courses. The boundary on the northeast is a line running from Westfield to Millinerville. He thinks it may be plausibly referred to the sweeping of dust from the broad flood plain west by the wind. The writer approved that view in his report on part of the same area in the Elk Point Folio, of the U. S. Geological Survey.

5. Crowning the highlands in northern Nebraska, which constitute the divide a few miles south of the Missouri river, are high ridges of loess, beginning as conspicuous headlands at the northwest ends, and running southeast and widening till they coalesce in a general sheet. It may be that they are remnants of an area similar to that just described, which formerly accumulated south of the Missouri and lower lands of South Dakota, as the former did on the east. The gathering ground for that older deposit was the surface succeeding the Kansan stage of the ice age, while that for the Plymouth county area was succeeding the Wisconsin stage.

6. In the cases considered thus far we have no carefully prepared topographic maps to give quantitative expression to our facts, but recently some excellent maps have been made of limited areas in southeastern Nebraska. From these we glean a few facts pertinent to our subject. In the northeast one-fourth, section 8, township 3 north, range 17 east, Richardson county, Nebraska, on the Falls City topographic sheet is a sharp peak rising 1,260 feet above the sea and 380 above the river less than half a mile away. It is only 20 or 30 feet higher than several others near by and scattered along the very verge of the upland, and just south of an east-southeasterly course of the Missouri and south of a wide flood plain of that stream stretching north-northwest many miles. A remarkable feature of this case is that upland level to the southwest rarely rises above 1,150 feet. We may add that the upland level on the east and west sides of the river further north is about the same, viz., 1,150 feet. Here again, therefore, we find another example of unusual altitude attained by accumulation of dust from an adjacent river valley, this time on the west side of the river, though still to the southwest of the gathering area.

7. Quite a different accumulation of loesslike silt was hastily observed by the writer in the southern Black Hills, not far from Chilson station, in Fall River county, South Dakota. There great dust drifts, 20 to 30 feet high, lie like great snow-drifts. A railroad cut through one showed its homogeneous and structureless nature, and buff color, in all these respects resembling closely the loess along the Missouri river.

8. The last case we record is at Thermopolis, Wyo. It is a sheet of reddish loam 15 to 25 feet thick, lying on a broad, flat deposit of travertine many feet in thickness and rising 400 feet above the Big Horn river, close by. Evidently the travertine was the deposit of the hot springs which are still continuing such work at much lower levels. The upper deposit is much the older, made before the drainage had been lowered. The north side of the travertine-capped ridge is quite abrupt. No theory for depositing the fine loam by water can be reasonably formulated. It is clearly another case of raising of dust from lower levels up a steep slope and spreading it on the comparatively flat summit. The loam has a distinctly reddish tint, corresponding to the "Red Beds" which comprise much of the surface on the north.

THEORETICAL EXPLANATION. The seventh case may be sufficiently accounted for by conceiving it to be quite analogous to the formation of common snowdrifts. In the other cases there is the difficulty of raising the material to greater height and spreading it out as a thin sheet. The conditions apparently essential to these are the following:

(1) Broad, bare areas of sand bars or mud flats, where the wind has free sweep at them.

(2) A precipitous slope lying athwart the course of the wind, steep enough to turn the stream of air sharply upward, with velocity sufficient to prevent any wind striking the top of the bluff horizontally; in fact, so as to produce a still area with a partial vacuum there. Such areas are easily found on flat-topped buttes, or on flat-roofed buildings on windy days. I have frequently found a difference of .02 inch air pressure, on the same level, between the verge of the level in the wind and back a few feet in the still air.

(3) A flat area of some extent, covered with vegetation of some sort, which will prevent the dust which settles there from being blown away by the gentler breezes which will strike the surface horizontally, and from the wash of the rains. Grass is probably best suited to do this.

Under such conditions the wind gathers the sand and dust from the bars on windy days. They may be often seen rising like smoke along such streams as the Missouri. When the air is turned upward by the steep bluff, the sand is mostly arrested at lower levels. The dust goes on, and may be augmented by more wrenched from the side of the bluff where the friction is great.

After the wind regains its horizontal direction after its upward turn, the dust will gradually and quite evenly settle out of it into the still space below, where it is apt to rest protected by the vegetation from the rains and horizontal breezes, until it is undermined and carried away by ravines cutting back from the adjacent slopes.

UNIVERSITY OF KANSAS, LAWRENCE.

FIVE YEARS' EXPLORATIONS IN THE FOSSIL BEDS OF ALBERTA.

CHARLES H. STERNBERG.

IN the early part of the year 1912, with my son George F., I went to the Victoria Memorial Museum at Ottawa, Canada, with a skeleton of a Kansas mosasaur, *Platecarpus coryphæus;* a large fossil fish, *Porthus molossus;* and a skeleton of a *Titanotherium*, which I discovered in the Oligocene of Niobrara county, Wyoming. The other two skeletons George found in the Kansas chalk. We mounted this material, working from March until sometime in June. We found there a great museum building with little original material for exhibition, chiefly casts, and a few common fossil reptiles from Europe. Doctor Brock, the director of the museum, was anxious to secure the services of myself and my sons to build up for their museum a collection of the wonderful horned, crested duck-bills, and plated dinosaurs of the rich fossil beds of the Red Deer river. The Survey had discovered these beds twenty-five years before.

Barnum Brown, the great fossil reptilian collector and student, was already reaping a rich harvest in this field for the American Museum of Natural History of New York. Although collectors had spent three seasons in this field early in our century, no complete skeletons for mounting were added to their store until the fall of 1912, when my son, Charles M., found a thirty-two foot duck-billed dinosaur of the genus *Trachodon*. The skeleton was complete except the tail. We mounted it as a slab mount in the Victoria Memorial Museum. Mr. L. M. Lambe, the vertebrate paleontologist of the Geological Survey, in a popular description of it in the *Standard*, Montreal, Canada, August 23, 1913, says in his title to the illustration: "Canada's first complete dinosaur. This magnificent specimen, which is now in the museum of the Geological Survey, in Ottawa, is the one discovered last year in the bad lands of Alberta. The animal is supposed to have lived over 3,000,000 years ago. It is the first complete skeleton of its kind in Canada." We also found another genus of the trachodonts not yet described. This material was from the Edmonton series of the Cretaceous, supposed to approach closely the Lance beds of Wyoming.

We entered the field at Drumheller, Alberta, the center now of a rich coal field with extensive mines. The chasm of the Red Deer river is about two miles wide, nearly five hundred feet deep, with exposed strata on each side of the river. Here is a brackish-water deposit of clays and fine sand, with coal beds of enormous areal extent—simply inexhaustible. The farmers are allowed to mine all the coal they need for their own use, on the payment of a small royalty.

The next season I moved down the river eighty miles from Drumheller to the fresh-water deposit of the Belly river series, which is of the same age as the Pierre, which lies immediately above, showing that in this region the land had been elevated above the Pierre ocean. We found Pierre plesiosaurs in the Belly river beds, showing that the rivers and bayous emptied into the sea near by. The plesiosaurs swam inland and often left their bones to mingle with the land and swamp dinosaurs.

Doctor Brock, the director of the Geological Survey, and deputy minister, who employed me, says in his report for 1912.[1]

"Perhaps the most notable additions to the collections, at all events the most striking, have been the dinosaurs collected the past season by Mr. Charles H. Sternberg, perhaps the best-known collector in the world, whose specimens are to be found in all the great museums. The services of Mr. Sternberg and his son Charles have been secured, and he was sent on a well-equipped expedition to collect vertebrate remains from the rich bone beds discovered by the Geological Survey twenty-five years ago in the Red Deer river, Alberta. This expedition was fortunate enough to discover two complete specimens of the large duck-billed dinosaurs. A well-equipped vertebrate paleontological laboratory has been installed, and in it one of the specimens, thirty-two feet long, is being mounted by Mr. Sternberg and his son, as a panel mount."

In his report for 1913[2] Doctor Brock says:

"The most notable additions have, however, been made in vertebrate paleontology. Mr. C. H. Sternberg, assisted by his sons, has succeeded in recovering from the Edmonton and Belly river beds of the Red Deer river a priceless collection of the monsters that formerly inhabited this region. The material is rich, not only in new species, but in new genera, and many of the specimens are, therefore, type specimens. Several striking mounts of these animals have been prepared and are on exhibition, and good progress has been made on others, which will prove of exceptional interest and value."

Among the wonderful dinosaurs of the Belly river formation, I believe the most unique is Lambe's *Styracosaurus albertensis.*

1. Summary Report of the Survey, 1912, p. 8.
2. Ib. 1913, p. 11.

I was so fortunate as to discover it in a deep gorge in the bad lands below Happy Jack ferry, twelve miles below Steveville. Only the skull was present. It is over six feet long. A huge horn core crowned the top of the nose, which must have been three feet long in life. Projecting behind were six horn cores, radiating from the back margin, the longest ones being twenty-six inches long. I believe the entire top of the head, crest and horn cores were sheathed in horn. I also believe that this head was used in life as a shield to protect the vital organs. The skin was covered with small scales arranged like mosaic work in a payment. When he was attacked by a carnivorous enemy he stood at bay and presented this impenetrable armor of defense.

The most valuable specimen found in 1913 was the nearly complete skeleton of a great carnivorous dinosaur. Mr. Lambe has named it *Gorgosaurus libratus*. This specimen, the most complete of any Cretaceous carnivore known, was found by my second son, Charles M. The skeleton is nearly complete, with the skull and lower jaws, with all the teeth present. The most remarkable thing about it is that the front limb and the ventral ribs are with it and in position, for the first time in a single individual. Twenty-eight feet of the skeleton was found. The hind limbs are ten and a half feet long; the feet themselves over three feet long, armed with great claws, which were once covered with horn. Terrible weapons, indeed! The jaws are three feet long and armed with long, serrate-edged teeth, many of which are six inches in length. The front limbs were vestiges, twenty-three inches in length, with no apparent use. The ventral ribs sheathed the abdominal walls as if hooped in steel.

Among the duck-bills was the wonderful hooded species, with footed ischia. The head resembles that of a cassowary, the remarkable crest extending high above the top of the head, so the height was equal to the length. The footed ischia allowed the reptile to rest on them when he squatted down on the hind limbs. They indeed acted as a third leg, and not the tail as the early paleontologists thought. I have proved him to be a swimmer, in the "dinosaur mummy" my son George found in Wyoming, in 1908. I also believe his natural pose was that of a lizard. Mr. Barnum Brown, of the American Museum of Natural History, made the discovery of a still more perfect

skeleton of a crested dinosaur, which he names *Corythosaurus casuarius.* In this skeleton not only is the skin impression preserved, but the impression of the muscles and the animal's pose, as if in the act of swimming. It has a beautiful head on a long, swan-like neck, a huge body, and a long, eel-like tail. Deckert, in an ideal picture, has simply put one in his native element with the exact pose in which he died. I claim, however, that he overreaches the evidence when he stands two other forms on their hind limbs and tail, in the same picture. I will not go so far as to say that it is impossible for the creature to rise on his hind limbs; however, I do claim that it is an unusual position. I hope some day to see preparators put these creatures down on mother earth, or in the water, where they belong. When the creator shows us such wonderful specimens which absolutely contradict the preconceived opinions of men, whom should we follow?

Among the horned dinosaurs, George F. Sternberg and myself each found a skeleton of a very beautiful form, much smaller than the *Triceratops* of a later day. Mr. Lambe gives the new generic name of *Chasamosaurus,* due to the great openings in the crest. Mr. Brown, however, retains the name *Ceratops,* which Marsh gave to his Judith river species on which the family *Ceratopsia* is founded. In George's specimen we have the most perfect one of a horned dinosaur with which I am familiar. It is over five feet long, with great openings in the crest, the central bar thick in the center and beveled to a thin margin, the cross bone behind at right angles to it. I now know this bone is distinct from the skull, although it has always been called parietal. It is deeply notched in the median line. Powerful jaws hold magazines containing over two thousand teeth in three parallel rows, their grinding surfaces beveled above and below a pair of scissors, with which to shred their food after it is nipped off by the broad duck bill in front. The skin impression, too, is distinct from what has been claimed. There are pictures extant covering the thick, rhinoceroslike skin with heavy dermal scutes, a necessary protection imagined by men who neither knew the habit or the environment of the animal they recreated from a few scattered bones. In my specimen I secured many examples of the skin impression, proving it to be thin, clad in small scales, arranged like mosaic

work in a payment, five-to-seven-sided figures, or rounded in shape, often two inches in diameter, with many closely crowded, small six-sided scales, down to mere tubercles, as a background for the ornamental ones. They are not imbricated or overlapped; each scale is distinct, almost touching the edges of the ones opposite. The head was the largest part of the creature, and the crest behind nearly covered the small body. One skull is mounted at Ottawa and the other rapidly approaching completion.

Charlie and I secured two fine skulls of another strange form, which Mr. Lambe calls *Centrosaurus*, but Brown retains the name Cope gave the form he found in Montana in 1878, namely *Monoclonius*. By the way, I went with two other members of the Geological Survey to the Judith river of Montana in 1914, and went over the field I had explored with Professor Cope in 1876, and from incontestible evidence was forced to the conclusion that the Judith river beds of Montana are identical with those of the Belly river series of the Red Deer river of Alberta. These huge skulls had small round openings, across which lay bundles of ossified tendons, resembling horns. These were likely bony tendons, strong and elastic, used to move the lower jaws. A pair of recurved horn cores in the central line of the crest behind are also characteristic of this great dinosaur, nearly as large as *Triceratops*. We have mounted two fine skulls in Ottawa. Charlie's specimen, though somewhat crushed, reveals distinctly every bone that goes to make up the head.

Charlie also found the magnificent skull of the trichodont, which George Sternberg mounted for the Survey. Mr. Lambe considers this new, and calls it *Grypsosaurus*. It closely resembles Brown's *Kritosaurus*, from New Mexico. This skull is the most perfect of any of the trachodont family. It is of huge proportions, with high quadrates and exceedingly high nasals. These help to form a large Roman nose. Still another species of the trachodonts was discovered, and is evidently new. Levi prepared it last winter, and I expected to see it described. It was described, however, by Mr. Brown from a much poorer specimen. He calls it *Prosaurolophus*, a name indicating it to be an ancestor of the *Saurolophus*, which he described from the Edmonton beds. Last summer I found

a still better specimen of the same species—complete, in fact, which was sent to the British Museum. With it were the front and hind limbs sufficiently complete to enable Dr. A. Smith Woodward to get the correct proportions—a vital thing in connection with the skull, for the identification of scattered material.

The specimen most unique and desired is a complete skeleton of the great plated dinosaur *Stegosauria,* with its wonderful arrangement of bony plates in place. George discovered a nearly complete skeleton with the skull, which Lambe calls *Stereocephalus tutus.* In this species there is a clublike protuberance at the end of the tail. I secured one with a few feet of the end of the tail. There are three great bony sections, spherical in form, flattened above and below, seventeen inches long, thirteen inches wide, and ten inches high. The distal caudal vertebræ are welded to gether by the ossification of the tendons, which lie along the spines and chevrons, into a round solid handle, as it were, which is inserted into the center of the dermal plates and united to them. What a powerful weapon with which to break the ribs of a carnivore if he got near enough, though he really needed no defense, as he could safely trust his armor, which evidently covered the entire body and is anchylosed to the top of the head. Its arrangement, to my knowledge, is not yet well known. Brown, in his restored *Ankylosaurus,* once attempted to arrange the dermal plates, but unsuccessfully, as must always be the case unless it is first seen in the specimen itself.

A wonderful discovery of Brown's is that the great plates of bones which cover the entire body have small nodules of bone arranged beneath the body, like the chain armor of the old Roman soldiers, allowing motion of the skin in any direction. This is very different from the turtle and the *Glyptodon,* which are encased in an immovable armor for life. Mr. Lambe's studies have shown that these animals wear around the neck, next to the skull, a necklace of bony plates with keeled centers. I was so fortunate two seasons ago as to find a number of the plates in position over the dorsal spines. We found pelvic arches six feet in width and ribs five feet long, showing the enormous proportions of this form. I know Mr. Brown has a large amount of stegosaurian material, and I hope soon to see it published. The skull, as is common in the family, is quite

small, the jaws sheathed in horn. The small teeth behind show little sign of much use. It would not surprise me to find species with none in functional use.

I would like to tell of other wonders of the Belly river series and the results of our four years' labor there, but time and space forbid. I have calculated that it will take twenty years of careful labor by four competent preparators to get all the material in shape for study and exhibition. Last season Levi and I were in the employ of the British Museum, collecting in the Belly river series, below Steveville, Alberta. We secured three skeletons of Brown's *Corythosaurus*, which can be mounted, two we hope as slab mounts in their own matrix, and one as an open mount. We secured forty-five large boxes full of the material. Besides the dinosaurs, we found a new turtle and a fine shell of one already known.

LAWRENCE.

THE COMANCHEAN OF CENTRAL KANSAS.[1]

W. H. TWENHOFEL.

INTRODUCTION.

THE Comanchean of central Kansas is represented in the marine Mentor beds and associated strata. That these beds are of Comanchean age has been known to stratigraphers for many years; but so far as students who are not expert stratigraphers are concerned, there has been some uncertainty as to their exact stratigraphic position. Three things are responsible for this state of affairs, namely: the general inaccessibility of the literature relating to these beds; the fact that no Comanchean is shown in central Kansas on the geologic map of the state which has been published by the State Survey; and that description of the Mentor beds in volume II of the State Survey is given under the title of "The Dakota Sandstone."

It is the hope of cleaning up this uncertainty that has been the incentive for the preparation of this article, which is intended to be preliminary to a more extended treatment of these strata and their faunas.

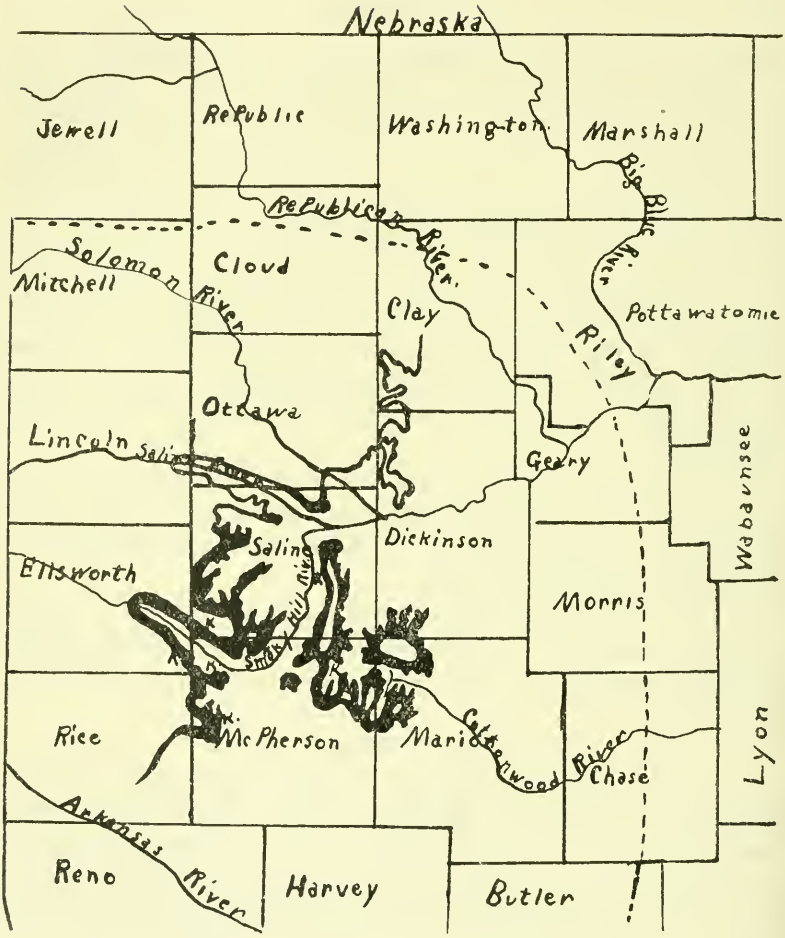
At the close of the article there is given a list of the more important papers in which the Comanchean of central Kansas has been considered. The small map shows the distribution of the beds.

SUMMARY OF INVESTIGATION.

For many years the Mentor and associated beds were included in the Dakota sandstone, of which the base was hence considered to be of marine origin. As a consequence of this assumption there are numerous references in geological literature to the marine fossils in the Dakota sandstone of Kansas, and some hypotheses have been erected on their supposed presence.

The first person who appears to have noticed the fossils at the base of the red Cretaceous sandstones of central Kansas was Dr. John L. LeConte. While with a party making surveys for the extension of the Union Pacific railroad to the west of Salina, he collected fossils to the south of Spring creek cross-

1. Published by permission of the director of the Kansas Geological Survey.



The surface distribution of the Comanchean strata of central Kansas.

The Comanchean areas are shown in black. Exposures of the Kiowa shell beds are indicated by the letter *k*. In southeastern and southern Ottawa, northwestern Dickinson and southwestern Clay counties the representation of the Comanchean's presence lacks the support of fossil evidence. The dotted line represents what may have been the eastern shore of the Comanchean sea. It is probably placed too far north.

ing. This locality is near the present little village of Bavaria (1:7).* He referred the fossils to the Dakota, and mentions that Professor Mudge had collected fossils near the same place. This was in 1867.

Subsequently (1871), Professor Mudge gave some details of the locality where he discovered the shells (2:38), and these were later described without figures by Meek (3:297). Four years later Meek revised his descriptions and accompanied them by figures (4, pl. 2), and two years afterward Professor Mudge gave further details relating to the places from which he obtained the fossils (5:67; 6:291).

Of more recent date are the articles of Prof. F. W. Cragin, who first clearly recognized the Comanchean or Lower Cretaceous age of the Mentor beds and carefully sought for their outcroppings, particularly in Saline county. It was he who proposed the name of Mentor for these strata, and he described several new species therefrom (11). Prosser compiled the results of the labors of previous students and extended the knowledge of distribution and details of stratigraphy (9:182), while later papers have been prepared by Gould (14 and 15).

The existence of strata in central Kansas with both the lithic and faunal aspect of the Kiowa shales[1] appears to have been first recognized shortly prior to 1889 by Professor Cragin, his note calling attention to their presence appearing in that year (10:37), and the following year he gave details relating to distribution (11:80). Prosser gave further details (9:179), while Prof. A. W. Jones, of the Kansas Wesleyan College, has given the latest word on these strata (12:111).

GENERAL RELATIONS.

In southern Kansas the Comanchean beds rest unconformably on the red beds of the Permian and are overlain by thin unfossiliferous sands and shales which have been called the Dakota, or by the overlapping continental deposits of the Plains Tertiary, and in some places both the Dakota and Comanchean are absent, so that the Tertiary rests directly on the Permian. In central Kansas the relations are similar so far as the underlying strata are concerned, the Comanchean

* See bibliography.

1. The Kiowa shales and the underlying Cheyenne sandstones are the divisions of the Comanchean which occur in southern Kansas.

lying on the Permian, but not the same stratigraphic unit as farther south, in McPherson county this appearing to be either the basal members of the red beds or the Wellington shale, and in the neighborhood of Salina the Marion formation. The overlying strata are either the leaf-bearing beds of the "Dakota" or unfossiliferous sands and shales of the same formation.

The geographic limits of the central Kansas Comanchean are probably not yet completely known, and it is not unlikely that their former eastward extension is far greater than has been supposed. So far as existing distribution is concerned, it has been learned that there are outcrops on the slopes above the river flood plains over the whole of Saline county, northern and northwestern McPherson county, northwestern Marion county, southeastern Ellsworth county and northeastern Rice county. Unfossiliferous strata of a lithology identical to that beneath the fossiliferous Comanchean rest on the Permian of southwestern Dickinson county, while strata somewhat similar occur in southwestern Clay county, southern Ottawa county, and southeastern Lincoln county. The writer considers all of these strata of Comanchean age. Mudge reported fossil shells in the Dakota of Clay county, but the writer was not able to obtain any. This gives outcrops of strata which are positively Comanchean over an area approximating five hundred square miles, but with many Permian inliers and Dakota outliers within the area. How far west beneath the Dakota the Comanchean beds extend is not known, and remains a problem for future investigation.

There are no known connections between the Comanchean beds of central Kansas and those of the southern part, the two areas having been completely severed by the great overlapping salient of the Tertiary which covers the divide between the Arkansas and Cimarron rivers, this tongue also having severed the Cretaceous of the north from that of the south.

That the Comanchean beds are separated from the underlying Permian by an erosional conformity follows from the fact of the vast interval of time between the times of deposition of the two systems of strata. The surface of the Permian appears to have been one of some relief, but the observations which have been made respecting this point are too few for generalization. In many places there does not appear to be

any of either the Mentor beds or the underlying, the Dakota resting directly on the Permian. Such areas may have been islands in the Comanchean sea[2]; the region may have been near the northern shore of this sea, which because of the brief existence of Comanchean waters in central Kansas must have been one of reëntrants and salients, upon the latter of which there could have been no deposition, so that now they would project, tonguelike, into the fossiliferous areas; or the Comanchean beds were eroded out before the deposition of the subsequent Dakota.

The last hypothesis raises the question as to the upper surface of the Comanchean strata. Has this been eroded, or are the Dakota beds continuous therewith? The writer is aware of no evidence showing that erosion followed the deposition of the marine sediments, and it appears highly probable that the continental deposits of which the basal Dakota is composed rests directly on the Comanchean strata. If this view be correct, there is opened the question as to the upper limit of the Comanchean. The writer is of the opinion that it should not be drawn at the top of the Mentor beds, but should include some of the beds which are called the Dakota.

DETAILED DESCRIPTION OF THE COMANCHEAN STRATA.

KIOWA SHALES. The Kiowa shales of central Kansas have exercised no marked influence in the development of sharp features in the topography. Being thin and offering little resistance to erosion, they weather readily and generally underlie grass-covered slopes. The locality where they were seen by the writer to best advantage is in Walnut township of Saline county, three miles east and two miles south of Mentor, where at an elevation of about 140 feet above the Smoky Hill river there are exposures along the side of the road in fully a dozen places of three to four feet of an oyster-shell limestone. In places the rock is partly crystalline. Overlying the limestone is an unfossiliferous red sandstone, while further down the slope in the float were collected a few blocks of sandstone containing Mentor fossils. In the road ditch below the limestone are excellent exposures of laminated, shaly yellow sandstone.

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2 A supposition to the same point was made by Professor Mudge (5, 6).

At the Natural Corral, a box canyon in section 5 of South Sharps Creek township, McPherson county, there are excellent exposures of both the Kiowa and the Mentor, in which the relations to each other and the underlying Permian Wellington shales are well shown.

On the rim of the canyon is the Mentor, with an exposure more than a mile long. It consists of a hard brown sandstone of about eight feet thickness. This contains the Mentor fauna, but fossils are not nearly so common as they are in some of the exposures in Saline county, and in many places they are extremely rare, or even wanting. Below the fossiliferous beds are from six to twelve feet of yellow, shaly, cross-laminated sandstone, underlying which are from twelve to fifteen feet of very friable sandstone. This is highly cross-laminated, and parallel to the lamellæ it is striped with yellow, red, brown and white. This sandstone is readily carved, and at the spring near the head of the corral it bears a record of hundreds of names and dates. No fossils were observed in either of these sand divisions. Below the sands are from thirty to forty feet of blue, black and yellow mud shales, at the base of which there is a two- to four-inch layer of gypsum, with decided cone-in-cone structure. Interstratified in these shales are soft yellow sandstones and sandy shales which at other places in the vicinity have yielded dicotyledonous leaves belonging to "Dakota" species. Such a locality is about two miles east of the corral (14-36). Beneath the shales are two thin beds of limestone, separated by about two feet of shale, each of the limestone beds being approximately six inches thick. In these limestones have been collected sixteen species of Kiowa invertebrates. They are underlain by twenty feet of unfossiliferous blue and black shales, in which are numerous pyrite nodules and selenite crystals. The lowest division of the Comanchean strata consists of four feet of yellow and gray sandstone, containing indeterminate plant remains. This division rests on the red and blue shales of the Wellington.

Throughout the greater portion of South Sharps Creek township the Kiowa shales are excellently exposed on the slopes at about the 1,600-foot contour, and exposures are equally good in southeastern Ellsworth county. About twelve miles west of McPherson and ten miles south of the Corral there are extremely good exposures of both the Kiowa, the

Mentor and the associated unfossiliferous shales and sandstones. Fossils are extremely abundant in the Kiowa. Prof. C. N. Gould obtained Kiowa shells about eight miles southeast of Lindsborg, while Prof. J. A. Udden obtained them a short distance west of that city (9:180).

In the road about three miles north of the village of Marquette, underlying cross-laminated sandstones similar to those beneath the Mentor at the Natural Corral, there are outcrops of a cone-in-cone gypsum similar to that at the Corral. Near by, in an arroyo, is an exposure of about eight feet of shales and sandstones, which are like those above the cone-in-cone layer at the Corral. In section 33 of Summit township, McPherson county, is an exposure of about eight feet of blue shales which are overlain by at least six feet of cross-laminated yellow sandstone. In the shale is a lens of the cone-in-cone gypsum. No fossiliferous beds were seen at either one of these localities.

The above are all of the localities in central Kansas where the writer has been able to find beds of Kiowa aspect, or to which reference has been made in the literature. The map has the localities where the Kiowa shell limestones are known to occur indicated by the letter K.

THE MENTOR BEDS. In the Mentor beds it is proposed to include only the fossiliferous sandstones and such other beds associated therewith as can be proven to be of marine origin. The thickness of these beds totals about ten feet. The unfossiliferous beds below the Mentor to the Kiowa belong apparently to another type of deposition and should be given another name.

Sections with good exposures of the Mentor are extremely rare, and such were seen only at the Natural Corral and immediate vicinity, and to the west of Smolan. At many localities were seen sections showing strata of a lithology similar to that of the unfossiliferous beds below the Mentor. These are considered to belong to the Comanchean, but not to the Mentor.

The Mentor beds are quite variable locally. At the type locality they consist of dark brown, friable, fine-grained sandstone. At the Natural Corral the rock is a heavy-bedded brown sandstone of coarser grain than at Mentor, and in places it carries many of the ferruginous concretions which are so characteristic of the Dakota. Fossils are not extremely abundant

at the Corral, and where the rock is concretionary they are quite rare, apparently having been destroyed by the processes which developed the concretions. Near Smolan the rock is almost an iron ore and would pass for a fossiliferous hematite. Parts of the rock at this locality are so full of fossils that it is a true fossil coquina with the shells replaced by iron oxid and cemented by the same substance. This is the most fossiliferous lacality that was seen.

The most eastern point where Mentor fossils have been collected is in northeastern Marion county, about half way between the villages of Lehigh and Waldeck. The rock was not seen in place, but was found lying in the road ditches, and consisted of soft red fossiliferous sandstone. The ditches were cut in unfossiliferous yellow sandstone like that seen elsewhere beneath the fossil-bearing beds, and similar beds occur on the Rock Island right of way near the station of Waldeck. The most northern locality for Mentor fossils is in section 18 of Cambria township, Saline county. This is about seven miles north of Salina, and the fossils occur in loose blocks lying on the slope. Below the fossil-bearing rocks outcrop gray to brown friable shales and sandstones, while above them are brown unfossiliferous sandstones. Gould states that Unios and other fresh-water shells have been found here (14:33). The writer did not succeed in finding any fresh-water shells. Professor Mudge reported shells from the "Dakota" of Clay county.

Other localities from which Mentor fossils have been obtained are near Windom, near the western margin of McPherson county, northeastern Rice county, southeastern Ellsworth county, near Brookville, Bavaria, southeast of Lindsborg, and many places in Saline county, where the Comanchean is shown on the map.

THE CENTRAL KANSAS COMANCHEAN FAUNAS.

The collections have not yet been submitted to careful study, and until that has been done little will be said relating to correlation. The evidence appears fairly clear, however, that the strata are of upper Comanchean or Washita age. The lists of species which follow have largely been compiled. From the Kiowa have been collected the species which are named in the first list. Other species in addition to those named appear to be present, but identifications have not yet been made.

Avicula salinaensis (White).
Anchura kiowana Cragin.
Cardium kansasensis Meek.
Corbula sp.
Dentalium sp.
Leptosolen conradi Meek.
Lunatia sp.
Mactra sp.
Nucula catharina Cragin.
Ostrea quadriplicata Shumard.
Ostrea sp.
Protocardia texana Conrad.
Pholadomya sancti-sabæ (Roemer).
Tellina subscitula Meek.
Trigonarca salinaensis Meek.
Turritella belviderei Cragin.

The Mentor fauna is far larger than is the Kiowa, and it also appears to contain several species which are undescribed Those known are as follows:

Anchura kiowana Cragin.
Anomia sp.
Arcopagella mactroides Meek.
Avicula salinaensis (White).
Barbatia parallela Meek.
Cardium kansasense Meek.
Corbicula? nuculis Meek.
Corbicula? subtrigonalis Meek.
Corbula sp.
Crassatellina oblonga Meek.
Cyprimeria texana var. *kiowana* Cragin.
Cytherea sp.
Gervilia mudgeana White.
Inesalia Kansasensis Meek.
Leptosolen conradi Meek.
Margarita mudgeana Meek.
Modiola pedernalis Roemer.
Nemadon sp.
Nucula catharina Cragin.
Ostrea quadriplicata Shumard.
Protocardia texana Conrad.
Rourdaria quadrans Cragin.
Sphenodiscus pedernalis Von Buch.
Tapes sp.
Tellina subscitula Meek.
Trigonarca salinaensis Meek.
Trigonia clavigera? Cragin.
Trigonia emoryi Conrad.
Turritella kansasensis Meek.
Turritella belviderei Cragin.
Yoldia microdonta Cragin.
Woedia microdonta Cragin.

PROBLEMS OF THE CENTRAL KANSAS COMANCHEAN.

The Comanchean of central Kansas contains several problems which are of considerable stratigraphic importance. Those deserving most consideration are (1) the relations of the Mentor sands to the Kiowa shell beds, (2) the chronologic and systematic relations of the Dakota to the Comanchean strata, and (3) the former eastern and present western extent of the Kiowa shell beds and the Mentor sandstones.

In respect to the first problem, it appears quite probable that the basal deposits of the Comanchean are nonmarine. The shell beds are certainly marine. The shales and sands which follow are quite probably nonmarine, while the fossiliferous Mentor sandstones are assuredly marine. Depositional conditions leading to such a sequence would be present on an area undergoing slow subsidence—subsidence so slow that the land waters by infilling could essentially keep pace with

the downward movement and maintain the area as land. The shell limestone marks a time when subsidence may have gained on the infilling, which subsequently increasing in relative importance, filled the shallow sea with sands and muds. Subsidence again dominating over infilling, led to the deposition of the Mentor beds, filling up the sea once more, following which the Dakota beds of continental origin were deposited.

The second problem concerns the relations of the Dakota to the Comanchean. The earliest sands of the Dakota appear identical in lithology to those of the Mentor and conformable thereto. They appear to be those left on the deposits of a vanishing sea by an advancing of the continental deposits. Are these continental deposits of Comanchean or Cretaceous age? It is hoped that an answer to this question may later be attempted.

The third problem meets the difficulty that hardly anything is known of the deposits which lie underneath the Cretaceous areas to the west, but it is known that a thin edge of Comanchean strata is present near Canyon City, Colo., as well as at other localities in that state (13:657). These western deposits contain many species identical with those of the Comanchean of central Kansas, and it must be that either the sea extended directly over from Kansas to Colorado or swung southward. Which is the case remains to be determined.

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MEASUREMENT OF STRESSES IN RAILROAD TRACK.

(Abstract.)

C. C. Williams.

DURING the past two years experiments have been conducted in the Department of Railway Engineering of the University of Kansas to determine the amount, character and laws governing the stresses that occur in railroad track under traffic. The two main purposes have been—

1. To determine whether or not railroad track as it is now being built is the most satisfactory and economical type of structure that could be constructed to perform the functions required of it; whether it is consistently designed and properly proportioned.

2. To determine the laws of stresses occurring under traffic relative to speed and character or class of traffic, in order to allocate operating expenses equitably and accurately to the different branches of service, so that the cost of each may be resolved.

The tests were carried on by means of the Berry strain gage and a specially designed instrument which has been given the name of "track deflectograph." The latter automatically records, by means of a stylus on a revolving cylinder, the deflections of the track as trains pass over at various speeds.

Some of the more interesting observations relate to the positions of the truck wheels of the train for maximum stress, the relative stresses caused by freight and passenger trains, the effect of speed on stress, the effect of flat wheels on stress, the variation of stress with the type of rolling stock, and the vibrations of the rail under the passing of trains.

Future tests are contemplated with a view to determining the stresses in ties, a further study of vibrations, and the investigation of stresses occurring at rail points.

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THE SHOSHONI-GOSHIP INDIANS.

ALBERT B. REAGAN.

THIS group of Indians is locally known as the Goshute tribe. From correspondence with the Ethnological Bureau, it seems that no one has ever written them up in any way. From what I can learn they were first visited by the Mormons. At that time they dominated western Utah and Eastern Nevada south of the middle of the Great Salt Lake desert, far into the south half of these two states. After the discovery of gold in California the Overland route was made through the center of their territory within thirteen miles of the present Deep Creek reservation.

Following the middle of the last century, these Indians began to commit depredations on the settlers and on the Overland Route. The Overland station, just over the pass in the Deep Creek range, twenty-eight miles northeast of the Deep Creek Indian reservation office, was captured and burned and its inmates killed. This station was half way between Deep Creek (Ibapah post office) and Calleo eastward on the Lincoln Highway. A well and a rock wall still remain of this station to remind one of these old days. Deep Creek station, twelve miles north of the agency, fared better, as there were more whites near it. Eight Mile station, eight miles further west on the present Lincoln Highway, while able to withstand the attacks, had many a grim day. At one time, on the route from Deep Creek station to Eight Mile, the stage was attacked; the stage driver and the only passenger were killed, but the teams at a breakneck speed rushed down the road and through Eight Mile station gates with their dead. About the same time the stage coming from the west to Eight Mile, was attacked and the driver killed, but, as in the previous case, the frantic horses gained the station with the stage and their dead driver. The graves of these slaughtered men are just a little west of the old station house; and the old adobe fort, though now the residence of Mr. George Etta, has the bullet marks in its walls to remind one of the Indian attacks in those grim days. It is alleged that the old Indians now living took part in those raids.

To stop the depredations the War Department rounded up the Indians and compelled them to make a treaty with the Gov-

ernment, agreeing to cease hostile action in any way. From what I can learn, they have lived up to their side of the agreement. The goods and money-payment part of this treaty by the government were all fulfilled and the Indians turned loose to look out for themselves for many years. Recently, through a work-up agitation, they were given reservations and were again segregated on reservations. A part of the tribe was placed on the Skull Valley reservation, near Grantsville, Utah; and the remainder were placed on the Deep Creek reservation. The executive order establishing this reservation bears date of March 23, 1914.

As the Deep Creek section of the Goshutes began to civilize they were gathered in by the Mormon Church at Deep Creek, and for a number of years they were fathered by the church there. Then they were moved up to the site of the present reserve and the Mormon Church bought them a little tract of land there and also acquired a right to certain water for irrigation purposes. The church held the title to this land for a while, then deeded it over to the Indians. Soon, then, white men began to encroach on the Indian water rights. This led to a lengthy case of litigation, in which the Indians won a third of all the water of the entire watershed, and still hold the same with their newly constituted reserve.

Since the forming of the reservation many questions as to the Indian's status have arisen. One was with reference to the Indian's hunting. The Indians carried their case to the honorable commissioner and won their point. He decided that the order establishing the reservation left these lands "without the jurisdiction of the state, and therefore should Indians hunt thereon they would not be amenable to the state laws. They must, however, observe the federal law relative to hunting and killing migratory birds, and should they dispose of their catch while off the reservation they would be subject to the state laws for having such game in their possession, if in violation thereof."

These Indians, like all Indians, are great gamblers; and besides playing our games, they have a game of their own called ni-ay-way, at which they spend too much valuable time. Below is a description of the game:

THE NI-AY-WAY, OR TWO-STICK GAME OF THE GOSHIP INDIANS

In this game, two game sticks about two and one-half inches long and one-eighth of an inch in diameter and some tally sticks are used. One of the game sticks has a thread or a buckskin band around its center. When playing, the player holds one of the game sticks in each hand. These he changes from hand to hand behind his back, under a blanket or behind an apron (if a woman is playing), or at any place out of sight of the guesser, his opponent; though he faces his opponent in the open throughout the whole time he is playing. When playing, the players are two in number and sit opposite and about six feet from each other, though each set may be joined by many helpers and each may represent a whole clan or tribe. (In the game which I saw one side was the Skull Valley Indians, the other side the Nevada and Deep Creek Indians.) In this game the player having changed the game sticks to suit himself, brings his hands before him and swings them back and forth from left to right and the reverse, as he changes the sticks in sight or out of sight (concealed) from hand to hand by sleight-of-hand performance, to disconcert his opponent, and his colleagues sing a vigorous song in a monotonous minor key. A "good" player will change the sticks after the guess is made. As the player is thus acting the guesser is preparing to make his guess. He makes false motions with his hands, points to this hand and then to that hand of his opponent, while he argue and jokes to see if he can decide from his actions where the valuable stick is, in which hand it is held. Having decided in his own mind, he makes his guess (calls it) by slapping his hands together in a vigorous manner and then pointing his right hand toward the hand he has decided holds the mystic, winning stick. If he loses, his opponents begin again the vigorous song of triumph and commence to hide the sticks again. If he wins, the sticks are turned over to him. Below are the rules for playing the game:

1. The unmarked stick is the winning stick.

2. If the guesser guesses which hand the unmarked game stick is in, he gets the game sticks, but no tally, and the other side begins to guess.

3. The tallies are kept by an agreed number of tally sticks, each side at the beginning of the game having the same num-

ber. (In the game I saw each side had seven tally sticks when the game began.)

4. For every time a guesser misses he losses a tally, and a tally stick of his passes over to the winner and is placed with his pile of tally sticks.

5. When all the tally sticks have passed to the possession of either of the contestants, that side has won the game.

When playing this game, all squat, Indian style, on the ground, and the playing side pound chunks or boards with long sticklike clubs to make the most noise possible as they sing. When winning, they pound the most vigorously and sing with greater accent.

Also, as with other Indians, the Goshutes are great dancers. Besides dancing the white man's dances, they dance the round dance and the bear dance. Below is a description of each dance as danced.

THE ROUND DANCE OF THE GOSHIP INDIANS.

This dance is very similar to the Shoshoni "dragging dance," and also resembles the Sioux ghost dance of 1889. It differs, however, in that no drum is used and in the fact that it is a choosing-partner dance. The women choose their partners by going to the circle and forcing themselves between their choice and the next dancer in the circle and locking arms with each. Sometimes the squaw is rejected, and is ejected from the circle, as she is jeered by the spectators. Below is a description of the dance.

When all is ready, at about nine p. m., the leaders walk out to the dance place, and facing inward, join hands so as to form a small circle. All these first actors are men. Then, without moving from their places, they sing the opening song in a sort of an undertone. Having sung it through once, they raise their voices to their full strength and repeat it, this time slowly circling around in the dance. The step is very simple. The dancers move from right to left, following the course of the sun, advancing the left foot and following it with the right, hardly lifting the feet from the ground. various songs are sung, all adapted to the simple measure of the dance step. As the song rises and swells, the people come singly and in groups from their several houses and teepees, and one after another join the circle, until any number from fifty to one hundred are in the dance. When the circle is small, each song is repeated

through a number of circuits. If large, it is repeated only through one circuit, measured by the return of the leaders to the starting point. Each song is started in the same manner, first in an undertone while the singers stand still in their places, and then with the full voice as they begin to circle around. When once begun, the dance lasts throughout the remainder of the night. It leads toward the hypnotic, and is vigorously performed.

THE BEAR DANCE OF THE GOSHIP INDIANS

The Indians planned to have a bear dance. They had a common steel washtub inverted in the center of the proposed dancing area, and the musicians began to sing and draw notched sticks over the edge of this inverted tub, thus making a rumbling, horrible (to me), but rhythmic noise to the time of the song sung. For some reason the dance was abandoned.

However, I learned that it was a choosing-partner dance of the wagon-spoke type, the performers being arranged like the spokes of a wheel. The hub of the dance-wheel is the group of drummers and chanters. Around this hub there is a circular dancing area of a radius of, say, thirty feet. In this area the dancers dance. The squaws choose their male partners, usually one but sometimes two or more, by going up to the musician group and simply tapping her choice with her hand. Sometimes she gets the "glove" and has to dance alone. When ready, the actors dance a straight forward and backward dance on a radius, or spoke-line, of the wheel. The squaw faces the hub; her partner faces in the opposite direction. When she dances forward her partner (or partners) retrograde backwards, and when the hub is reached she retrogrades and they dance forward to the rim of the circle, the backward and forward sweep being a radius of the circle. The dancers often lock arms and dance side by side, but sometimes they face each other's right shoulder. A set lasts with the song sung, and at the beginning of each new song a new set is formed. This dance is picturesque.

HEALTH CONDITIONS.

These are the healthiest Indians I have met in seventeen years in the Indian service; yet an examination by Dr. Ferdinand Shoemaker, assistant medical supervisor in the United

States Indian Service, shows that they are badly diseased. Of 64 examined the following cases were found: tracoma, 27; consumption, 5; goiter, 3; enlarged glands, 2; arterio-sclerosis, 1.

The division of the Goshute tribe living at Deep Creek reservation numbers about 150. They are progressive and self-supporting.

BIRDS OF THE BOIS FORT INDIAN RESERVATION AND ADJACENT TERRITORY IN MINNESOTA.

ALBERT B. REAGAN.

THE BOIS FORT (or Nett Lake) Indian reservation, surrounding the beautiful Nett lake, is the home of the Bois Fort Indians. It covers one whole township and eight fractional townships. Its eastern part is in St. Louis county, the bulk in Koochiching county, covering townships and parts of townships as follows: townships 66 north, ranges 21, 22 and 23 west of the fourth principal meridian in Minnesota; also townships 65 and 64, same ranges as above. The reservation is located 125 miles northwest of Duluth and about 38 miles south of Fort Frances, Ontario. It contains a total of 103,862.73 acres, exclusive of the area of the lake, which comprises about three-fourths of a township. Of this about 56,000 acres are allotted to 718 Indians and 434.64 acres are reserved for agency and school purposes. Of the 47,428.09 acres unallotted, much of it was originally reserved by the government as pine lands, aggregating 9,533.93 acres; the remaining unallotted area was mostly swamp land. In 1909 the last of the pine was sold, and in 1914 practically all of the unallotted land was thrown open for settlement. Of the allotted land, more than one-half of the original allottees are dead. Consequently, something like 30,000 acres of inherited Indian lands will be sold within the next few years.

Nett lake is in the east central part of the reservation. As has been stated, it covers about three-fourths of a township. It is in the shape of a giant lobster's hand, with the claws pointing eastward, the larger claw being the north digit. The lake is shallow and has a mud bottom. It is a rice field and a duck pond combined. In summer it looks like a vast wheat field. In

the fall it swarms with ducks, and consequently is a sporting center for hunters of all that northern country.

The lands included in the reservation are well timbered. The principal species represented are white and Norway pine, spruce, cedar, elm, cottonwood, oak, maple, willow, various species of plums and cherries, birch and poplar.

The land is very variable in condition of soil and possible fertility. One-half of it is swamp and is known to the Indians as "muskeg" lands. Over this area is a stratum of peat from six inches to five feet in thickness. When once drained this will make the best of land. The nonswamp eastern part of the reservation is composed of rock ridges flanked with lower land. These lower stretches are clay flats covered with black loam. On these grow birch and poplar forests. The ridges are pine lands, and in the future will not be of much value except for building sites and orchard locations. The swamp areas are in the jungle state.

The western part of the reservation that is not covered with "muskeg" swamp is a sand region. On it grew much pine in the old times, but when cleared it will be practically worthless, as are some pine lands east of the south lobe of the lake.

The region about Little Fork river, in the southwestern part of the reservation, will make good farm land when cleared. Some open areas are fine meadows now.

The climate is very changeable, ranging from 102 degrees above zero in summer to 60 below in winter. There is a heavy snowfall in winter and an abundance of rain in summer.

The Indians have been allotted for twenty-five years, yet only a few have ever attempted to improve their allottments. There is rice growing in the lake and plenty of game in the woods and waterfowl among the rice in the lake.

As is seen, the region about Nett lake is in the virgin state. The same might be said of all the region extending southward and eastward nearly to Duluth and Lake Superior, and northward to the Arctic ocean, much of which is composed of swamps and lakes.

The above is given in order that the reader may have an idea of the character of the country about Nett lake and the birds to expect in the region and the conditions under which these birds make homes in the section.

The writer will add that Nett lake is eighteen miles west of the Orr railroad station of the Duluth, Winnepeg & Pacific railroad, running out from Duluth, and in the fall the sportsmen from all over the coutry come to Nett lake to hunt waterfowl. For days during the hunting season wagonload after wagonload of ducks are hauled across the portage to the railway station for outgoing successful hunters. For the hunter Nett lake is a paradise.

The observations here recorded extend over a period of five years (1909-1914), as time would permit while the writer was Indian agent at Nett Lake, Minn.

Unless otherwise stated, the birds mentioned in the list below are breeding, summer residents. The number opposite the name of each respective species is the number of that species in "Handbook of Birds of Western United States," by Florence Merriam Bailey.

LIST OF SPECIES.

2. *Colymbus holboellii* (Reinh.). Holboell Grebe. Common in summer.

6. *Podilymbus podiceps* (Linn.). Pied-billed Grebe; Dadchick. Common in summer and abundant in the fall.

7. *Gavia imber* (Gunn.). Loon; Great Northern Diver. A common summer resident; abundant in migration.

9. *Gavia arctica* (Linn.). Black-throated Loon. Occasionally seen in migration.

51. *Larus argentatus* Brunn. Herring Gull. Occasionally seen at Nett lake; common at Pelican lake, Vermillion lake and Rainy and Chain lakes along the international boundary line.

There are several other species of gulls that frequent the region, but not securing a specimen, I was unable to identify them. The gulls are summer residents at Rainy lake.

120. *Phalacrocorax dilophus* (Swain.). Double-crested Cormorant. Occasionally seen in migration. In the fall of 1913 the writer saw four at Nett lake on a stormy day. They are more frequent at Pelican lake, and likely spend the breeding season at Rainy lake and other lakes in that vicinity.

125. *Pelicanus erythrorhynchos* Gmel. American White Pelican. An occasional migrant at Nett lake; a frequent migrant at Pelican lake. A stuffed pelican killed at Orr, Minn., sits on the showcase in the saloon in that town. Hunters killed five specimens near Orr in the fall of 1913.

129. *Merganser americanus* (Cass). American Merganser; Goosander; Sheldrake. A few were seen in migration.

150. *Mergancer serrator* (Linn.). Red-breasted Merganser. A rare migrant.

132. *Anas bochas* Linn. Mallard. Summer resident and migrant, abundant. The writer would judge that 100,000 passed through the region in the fall of 1913.

135. *Chaulclasmus streperus* (Linn.). Gadwell. Rare.

136. *Mareca penelope* (Linn.). Widgeon. A rare summer resident; abundant in migration.

137. *Mareca americana* (Gmel.). Baldpate. A numerous migrant.

139. *Nettion carolinensis* (Gmel.). Green-winged Teal. A summer resident and numerous migrant. The writer would judge that 75,000 passed over the reservation in the fall of 1911, stopping a few hours in the lake to get a meal of wild rice while on the trip.

140. *Querquedula discors* (Linn.). Blue-winged Teal. A summer resident and numerous migrant. The writer estimates that at least 50,000 stopped and took a meal of rice at Nett lake while on their journey south in 1910.

142. *Spatula clypeata* (Linn.). Shoveler; Spoonbill. A numerous migrant; also an occasional summer resident.

143. *Dafila acuta* (Linn.). Pintail. An abundant migrant.

144. *Aix sponsa* (Linn.). Wood Duck. In the falls of 1909, 1913, and 1914 a few wood ducks were killed by hunters at Nett lake. They were also said to be summer residents of a swampy creek region northwest of the lake.

146. *Aythya americana* (Eyt.). Redhead. A common migrant and rare summer resident.

148. *Aythya marila* (Linn.). Scaup Duck; Bluebill. The most numerous waterfowl migrant, and the bird most killed by hunters. It is also a summer resident of the region. The writer would judge that between 110,000 and 125,000 of these birds made a rest on Nett lake in their flight south in the fall of 1912.

147. *Aythya vallisneria* (Wils.). Canvasback. A common migrant and rare summer resident.

149. *Aythya affinis* (Eyt.). Lesser Scaup Duck. A common migrant and a rare summer resident.

150. *Aythya collaris* (Donov.). Ring-necked Duck. A summer resident and migrant; not abundant.

151. *Clangula clangula americana* (Bonap.). American Gold Eye. An occasional summer resident; common in migration.

153. *Charitonetta albeola* (Linn.). Buffalo Head. A migrant.

154. *Harelda hyemalis* (Linn.). Old Squaw. An occasional migrant.

155. *Histrionicus histrionicus* (Linn.). Harlequin Duck. Occassionally seen.

167. *Erismatura jamaicensis* (Gmel.). Ruddy Duck. Occasionally seen in migration.

171*a*. *Anser albifrons gambeli* (Hartl.). White fronted Goose. Common in migration.

172. *Branta canadensis* (Linn.). Canada Goose. Common in migration. While geese were often seen flying over the region, they were known to light only rarely.

190. *Botaurus lentiginosus* (Montag.). American Bittern. A summer resident.

191. *Ardetta exilis* (Gmel.). Least Bittern. But few of this species were seen.

194. *Ardea herodais* Linn. Great Blue Heron. A common summer resident.

201. *Ardea virescens Linn.* Green Heron.

294. *Grus americana* (Linn.). Whooping Crane. Seen flying in migration.

206. *Grus mexicana* (Mull.). Sandhill Crane. Seen occasionally.

212. *Rallus virginianus* Linn. Virginia Rail.

214. *Prozana carolina* (Linn.). Carolina Rail; Sora.

221. *Fulica americana* Gmel. American Coot; Mud Hen; Rice Hen. These birds visit Nett lake and Pelican lake by thousands each fall to feed on the rice. Before cold weather drives them south they get so fat they can hardly fly. When fattened on wild rice, they gain a good flavor and are hunted both by whites and Indians.

224. *Steganopus tricolor* Vieill. Wilson Phalarope.

230. *Gallinago delicata* (Ord.). Wilson Snipe; Jacksnipe. Seen about the shores of the lake in early September.

232. *Macrorhamphus scolopaceous* (Say). Long-billed Dowitcher. An occasional migrant. It was also seen May 13, 1912, on Nett river where it appeared to be a summer resident.

239. *Tringa Maculata* Vieill. Pectoral Sandpiper. A common migrant.

242. *Tringa minutilla* Vieill. Least Sandpiper. A common migrant.

256. *Helodromas solitarius* (Wils.). Solitary Sandpiper. A rare summer resident; a common migrant.

273. *Aegialitis vocifera* (Linn.). Kildeer. Occasionally met with at Nett lake; seen as a summer resident at Ely and Winton, Minn.

274. *Ægialitis semipalmata* Bonap. Semipalmated Plover. Seen as a migrant in the latter part of July and during August each year.

300. *Bonasa umbellus* (Linn.). (?) Ruffed Grouse. (?)

300*a*. *Bonasa umbellus* togata (Linn.). Canada Ruffed Grouse.

Canachites canadensis canaa (*Tetrao canadensis*). Spruce Hen.

The Canada ruffed grouse and the spruce hen live in the region in great numbers. In the more open areas the grouse is found; in the thickly timbered areas the spruce hen is to be seen. The latter are to be found in the balsam and pine thickets, also in the cedar jungles bordering the swampy areas.

In the blueberry season both species come out in the open and feed on berries.

The meat of the spruce hen is darker than that of the grouse and has less flavor. There are thousands of each species on the reservation. They do not migrate, but bury themselves in the snow and remain all winter.

The spruce hen is very tame and easily killed. The writer has seen them sit on a limb and never move when shot at till probably the third or fourth shot would bring them down. He has also known a flock of them to get just out of the road and sit in the open and let a team pass them. Also once while making a trip with an Indian policeman, Peter Mesabe, from the agency to Ash lake, they came upon a spruce hen in the trail. Mr. Mesabe motioned to stop, that he wished to catch the hen. The writer wondered how he was going to do it, as they had no hunting accouterments with them. Mr. Mesabe approached the bird slowly, and when he got nearly to it, probably sixteen feet of it, it flew into a nearby cedar tree and perched itself on one of the lower limbs. Mr. Mesabe then squatted in the trail and took out one of the shoestrings from his leg-boots and tied it, in snare style, on the end of a stick some four or five feet in length. He then went, in bent form, in easy and careful strides toward the tree till he got under the bird. Then he slowly pushed the stick up by the side of the bird till the shoestring noose was open and directly over the bird's head. With a quick move he got the bird's head in the noose and with another quick jerk he brought the strangling bird down. The party had spruce hen for dinner that day.

305. *Tympanuchus americanus* (Reich.). Prairie Hen. A few strays of this species were killed in the region in 1913. They are residents farther south, according to report.

308*b*. *Pedioecetes phasianellus campestris* Ridgw. Prairie Sharp-tailed Grouse. Both in the falls of 1912 and 1913 a few birds of this species were killed on the reservation. They were found in the open areas, and it is believed by the Indians that the excessive hunting in the prairie regions of Minnesota, the Dakotas and in Manitoba is driving them into the wooded districts.

316. *Zenaidura macroura* (Linn.). Mourning Dove. A common summer resident.

325. *Cathartes aura* (Linn.). Turkey Vulture. The writer saw several birds feeding at different times; also many soaring about over the region.

332. *Accipiter velox* (Wils.). Sharp-shinned Hawk.

334. *Accipiter articapillus* (Wils.). American Goshawk.

347*a*. *Archibuteo lagopus sancti-johannis* (Gmel.). Rough-legged Hawk.

349. *Aquila chrysaetos* (Linn.). Golden Eagle. Not common, but seen soaring over the region now and then. A stuffed skin of a specimen killed near Ely, Minn., is to be found at John Shafer's establishment in that city.

352. *Haliaeetus leucocephalus* (Linn.). Bald Eagle. Rarely seen.

356. *Falco peregrinus anatum* (Bonap.). Duck Hawk. This is a very common bird, both as a summer resident and a migrant.

360. *Falco sparverius* (Linn.). Sparrow Hawk.

365. *Strix pratincola* (Bonap.). Barn Owl.

373. *Megascops asio* (Linn.). Screech Owl.

375a. *Bubo virginianus pallescens* (Stone). Western Horned Owl. Seen occasionally.

376. *Nyctea nyctea* (Linn.). Snowy Owl. Several specimens of this species were killed at Nett lake.

387. *Coccyzus americanus* (Linn.). Yellow-billed Cuckoo.

390. *Ceryle alcyon* (Linn.). Belted Kingfisher. Occasionally seen both on Nett and Pelican lakes; quite abundant along Nett river, the outlet of Nett lake.

393a. *Dryobates villosus leucomelas* (Bodd.). Northern Hairy Woodpecker. A summer resident and numerous migrant; some individuals stay in the region all or most of the winter.

400. *Picoides arcticus* (Swains). Arctic Three-toed Woodpecker.

401. *Picoides americanus* (Brehm). American Three-toed Woodpecker.

402. *Sphyrapicus varius* (Linn.). Yellow-bellied Sapsucker. Common in summer; also an abundant migrant.

405. *Ceophloeus pileatus abieticola* (Bangs). Northern Pilated Woodpecker; Cock of the Woods. Common in summer; also a numerous migrant both in fall and spring.

406. *Melanerpes erythrocephalus* (Linn.). Red-headed Woodpecker.

409. *Melanerpes carolinus* (Linn.). Red-bellied Woodpecker.

412a. *Colaptes auratus luteus* (Bangs). Northern Flicker.

420. *Chordeiles virginianus* (Gmel.). Nighthawk. A very common summer resident.

428. *Trochilus colubris* (Linn.). Ruby-throated Humming Bird.

444. *Tyrannus tyrannus* (Linn.). Kingbird.

456. *Sayornis phoebe* (Lath.). Phoebe.

459. *Contopus borealis* (Swains). Olive-sided Flycatcher.

461. *Contopus virens* (Linn.). Wood Pewee.

466a. *Empidonax trailii alnorum* (Brewst). Alder Flycatcher.

467. *Epidonax minimus* (Baird). Least Flycatcher.

477. *Cyanocitta cristata* (Linn.). Blue Jay.

486a. *Corvus corax principalis* (Ridgw.). Northern Raven. An occasional summer resident.

488. *Corvus americanus* (Aud.). American Crow. A summer resident, but not numerous.

494. *Dolichonyx oryzivorus* (Linn.). Bobolink.

495. *Molothrus ater* (Bodd.). Cowbird.

497. *Xanthocephalus xanthocephalus* (Bonap.). Yellow-headed Blackbird. Only a few were seen.

498. *Agelaius phœniceus* (Linn.). Red-winged Blackbird. Seen at the mouth of Nett river, May 13, 1912.

501. *Sturnella magna.* Meadow Lark.

507. *Icterus galbula* (Linn.). Baltimore Oriole. Seen in large flocks April 19, 21 and 29, 1911.

509. *Scolecophagus carolinus* (Mull.). Rusty Blackbird.

510. *Scolecophagus cyanocephalus* (Wagl.). Brewer Blackbird.

511*b*. *Quiscalus quiscula aeneus* (Ridgw.). Bronzed Grackle.

514. *Coccothraustes vespertinus.* Evening Grosbeak. An abundant migrant. First seen in large flocks April 26, 1911.

517. *Carpodacus purpureus* (Gmel.). Purple Finch.

521. *Loxi curvirostra minor* (Brehm.). Crossbill.

522. *Loxi leucoptera* Gmel. White-winged Crossbill. A rare visitor.

529. *Astragalinus tristis* (Linn.). Goldfinch.

533. *Sipinus pinus* (Wils.). Pine Siskins; Pine Finch. Birds of this species appeared in great numbers in the spring of 1911.

Passar domesticus (Linn.). English Sparrow. Just began to appear in the region.

534. *Passerina nivalis* (Linn.). Snowflake. Passed south in great numbers in the fall of 1911.

552. *Chondestes grammacus* (Say). Lark Sparrow.

554. *Zonotrichia leucophyrs* (Forst.). White-crowned Sparrow. An abundant resident.

558. *Zonotricha albicollis* (Gmel.). White-throated Sparrow. Very common, especially in migration.

567. *Junco hyemalis* (Linn.). Slate-colored Junco. Abundant winter, fall and early spring visitor.

581. *Melospiza melodia* (Wilson). Song Sparrow. Common summer resident.

583. *Melospiza lincolnii* (Aud.). Lincoln Sparrow.

584. *Melospiza georgiana* (Lath.). Swamp Sparrow. A common summer resident in the swampy regions; an abundant migrant.

595. *Zamelodia ludoviciana* (Linn.). Rose-breasted Grosbeak. A rather common summer resident.

604. *Sipza americana* (Gmel.). Dickcissel.

605. *Calamospiza melanvorys* Stejn. Lark Bunting. Seen in migration.

608. *Piranga erythromelas* Vieill. Scarlet Tanager. A rather common summer resident.

611. *Progne subis* (Linn.). Purple Martin.

612. *Petrochelidon lunifrons* (Say). Cliff Swallow. Seen on Little Fork river, May 21, 1912.

613. *Hirundo erythrogastra* Bodd. Barn Swallow. Seen in Little Fork Valley in May, 1912.

614. *Tachycincta bicolor* (Vieill.) White-bellied Swallow. Seen at the mouth of Nett river, May 19, 1912.

616. *Riparia riparia* (Linn.). Bank Swallow. Many burrows and nests were found along Nett river and Little Fork river in 1912, from May 5 to 19 of that year.

617. *Stelgidopteryx serripennis* (Aud.). Rough-winged Swallow. Seen in the Little Fork valley and at Big Falls on Big Fork river, in May, 1912.

619. *Ampelis cedrorum* (Vieill.). Cedar Waxwing. Common in the cedar thickets of the region.

Perisoreus canadensis canadensis Linn. Canada Jay. A resident throughout the year; most common in winter. They are as tame as pigeons and are known as "butcher birds" and "camp robbers." They are always found in the vicinity of lumber camps, where they feed off of the table crumbs.

622*a*. *Larius ludovicianus excubitorides* (Swain). White-rumped Shrike. A rare resident and migrant.

624. *Vireo oblivaceus* (Linn.). Red-eyed Vireo.

636. *Mniotilta varia* (Linn.). Black and White Warbler.

652. *Dendroica aestiva* (Gmel.). Yellow Warbler.

654. *Dendroica caerulescens* (Gmel.). Black-throated Blue Warbler.

662. *Dendroica blackburniae* (Gmel.). Blackburnian Warbler.

667. *Dendroica virens* (Gmel.). Black-throated Green Warbler. Seen on Little Fork River, May 21, 1912.

704. *Galeoscoptes carolinensis* (Linn.). Cat Bird. Only a few birds of this species were seen.

705. *Toxostoma rufum* (Linn.). Brown Thrasher. Only a few birds of of this species were seen, It is probably a resident.

728. *Sitta canadensis* Linn. Red-breasted Nuthatch.

735. *Parus articapillus* Linn. Chickadee. A common winter resident, abundant in late fall and early spring, and possibly a few are summer residents, though no nests were found.

748. *Regulus satrapa*. Licht. Golden-crowned Kinglet. A common summer resident.

749. *Regulus calendula* (Linn.). Ruby-crowned Kinglet.

761. *Merula migratoria* (Linn.). Robin.

766. *Sialia sialis* (Linn.). Bluebird. A common summer resident.

NOTES ON KANSAS MAMMALS, 1915.

D. E. Lantz.

SINCE my last previous publication of additions to the Kansas list of mammals[1] several additional discoveries have been made in connection with work done by members of the Bureau of Biological Survey, United States Department of Agriculture. The recent publication of a review of North American moles by Hartley H. T. Jackson[2] shows that instead of a single form of the common garden mole, there are undoubtedly three forms in the state.

Scalopus aquaticus machrinoides Jackson. The type locality of this subspecies is Manhattan, Kan. The form has a wide distribution west of the Mississippi river, ranging from central Minnesota and southeastern South Dakota southward in the Missouri valley, except in eastern Iowa, and westward over eastern Nebraska and northeastern Kansas. It occurs over the greater part of Missouri south to extreme northern Arkansas.

Scalopus aquaticus caryi Jackson. The American Museum of Natural History, New York, has specimens of this form taken at Long Island, Kan. The type locality of the subspecies is Neligh, Neb., and it was named in honor of Merritt Carey, of that place, who was long connected with the Biological Survey as a field naturalist. This mole is distributed over the greater part of central and western Nebraska, northwestern Colorado, and northwestern Kansas.

Scalopus aquaticus intermedius (Elliott). The type of this subspecies was collected at Alva, Okla. While specimens from Kansas are lacking, it is undoubtedly the form to be found in the state in the region south and west of the Arkansas river.

A bat taken by me at Medicine Lodge, Kan., in 1905 has been identified as *Myotis velifer incantus* (Allen). This form was previously known from San Antonio, Tex., and Carlsbad, N. M., and its occurrence in Kansas is a wide extension of its known range. It is the more surprising because the forms taken at Marble Cave, Mo., and Fort Reno, Okla., have been typical *M. velifer*. Such a curious crossing of range in mam-

1. Trans. Kansas Acad. Sci., vol. 22, p. 336; 1908.
2. North American Fauna, No. 38; Sept. 30, 1915.

mals could hardly occur in terrestrial forms, but only among animals with the powers of flight.

My former note[3] casting doubt on the record of the occurrence of the rice rat, *Oryzomys palustris* Harlan, at Neosho Falls, was the result of an error of judgment on my part. As the species is an inhabitant of salt marshes near the sea coast, I did not understand how it could inhabit places so far inland. Recently Howard H. Howell, of the Biological Survey, has taken specimens of the typical *Oryzomys palustris* in many localities, in Illinois, Kentucky, Tennessee, and Missouri, and there is, therefore, no reason to doubt that it also ranges into Kansas, and that the Goss specimen in the National Museum was actually taken at Neosho Falls.

The two additional moles and the bat herein recorded bring the number of mammals on the Kansas list to ninety-one.

Biological Survey, Washington.

3. Trans. Kansas Acad. Sci., vol. 20, pt. 2, p. 216.

INHERITANCE OF FERTILITY IN SHEEP.

EDWARD N. WENTWORTH.

THE inheritance of fertility in mammals is difficult of investigation because of the large number of environmental influences which may limit the full expression of the inborn ability of the animal with reference to gamete production. Sheep are particularly difficult animals to study in this particular, because of their extreme sensitiveness to changes in climate and food supply. Evvard has shown that ewes gaining lightly at time of mating produced only 1.44 lambs; ewes gaining a medium amount, produced 1.59 lambs; while ewes gaining rapidly produced 1.8 lambs. Hence if the basis of selection for high fertility be numbered of offspring at a birth, it is possible to make rather serious mistakes due to the failure of the number actually produced by a ewe to correspond closely with the inborn fecundity of the animal.

The figures quoted in the following paragraphs are derived from a study of 3,715 Southdown births recorded in pedigrees started from single births, and 5,313 matings recorded in pedigrees started from twin births. Table I shows the results for the first group and Table II the result for the second group.

TABLE I.—*Pedigrees started from single births.*

RELATIVE INFLUENCE OF SIRE AND DAM ON BIRTH NUMBER.

No. cases.	Sire.	Dam.	Average No. Progeny.	No. cases.	Sire.	Dam.	No. progeny.
1,872	1	1	1 29	1,872	1	1	1.29
925	1	2	1.28	570	2	1	1 25
14	1	3	1.43	12	3	1	1.50
570	2	1	1 25	925	1	2	1 28
306	2	2	1 34	306	2	2	1 34
10	2	3	1 20	6	3	2	1.17
12	3	1	1 15	14	1	3	1 43
6	3	2	1 17	10	2	3	1.20

TABLE II.—*Pedigree started from twin births.*

RELATIVE INFLUENCE OF SIRE AND DAM ON BIRTH NUMBER.

No. cases.	Sire.	Dam.	No. progeny.	No. cases.	Sire.	Dam.	No. progeny.
2,805	1	1	1 51	2,805	1	1	1 51
1,294	1	2	1 55	687	2	1	1 57
21	1	3	1 86	19	?	1	1 68
687	2	1	1 57	1,294	1	2	1 55
468	2	2	1 56	468	2	2	1 56
10	2	3	1 69	7	3	2	1 43
19	3	1	1 68	21	1	3	1 86
7	3	2	1 43	10	2	3	1 60

But one conclusion seems possible from the above—that there is no difference in breeding quality between twins and singles, and that consequently their genetic constitution must be nearly alike. Further evidence on the same point is found from a study of the mean breeding qualities of twins and singles. Combining the two sets of statistics, *having due regard to the frequency in which twins and singles ordinarily occur*, the mean breeding records for ewes are as follows:

Ratio cases.	Birth rank of dams.	Average number lambs at birth.
17,958	1	1.3274 ± 0.00234
9,052	2	1.3444 ± 0.00345

The difference between them is 0.0170 ± 0.00422—a difference nearly large enough to be statistically significant if the actual numbers given under the ratio existed. If the actual cases arising from each type of pedigree are considered, however, the differences are not significant.

Evidences of Mendelian inheritance are difficult to obtain owing to the impossibility of determining the genetic type of the grandparents, but such as exist are presented nevertheless.

If there is a true segregation of fecundity factors a comparison of the maternal grandparents with the birth rank of the progeny should give some idea of the factors being transmitted. It is inconceivable that the sire mated to a ewe should influence the number at a birth; but in order to test such an effect, statistical studies were made which showed that the birth rank of the sire had no effect on the immediate progeny. When both grandparents were single the average lambing was 2.07; when one was a single and the other a twin, the average was 2.11; and when both grandparents were twins, the average was 2.05. None of these differences are statistically significant, hence one could again conclude that twins and singles are not genetically different. However, when one of the grandparents was a triplet, the average was 2.43, which would suggest that in order to produce triplets, factors not present in twin or single producers must be present. The chance that the difference in favor of the triplet grandparents is significant is only two and a half to one, due to the small numbers from which triplet grandparents could be discovered. However, the uniformity with which this result holds, no matter how varied the source of the figures, gives the writer confidence in the conclusion that there is no genetic difference between twins and singles, but that triplets in sheep differ from either.

EXPERIMENTS UPON THE EXTIRPATION OF THE PITUITARY AND THYROID GLANDS IN TADPOLES.

Bennet M. Allen.

IN recent years great interest has been aroused in the glands of internal secretion. It has been found that these play a rôle of fundamental importance in metabolism and development. It is the latter phase of the subject that has especially appealed to the author and the students whom he has started in this line of investigation. While there has been a large amount of work done upon these glands in adults, there has been comparatively little study of them in embryos. The reason is not far to seek, since our interest is chiefly stimulated by the importance of these glands to medicine. The investigaors have naturally turned to the mammals for experimental study. In the study of embryology the development of the chick has chiefly attracted attention.

Now neither the mammals nor the birds nor reptiles afford ready facilities for the study of the functions of these glands during embryonic development. A few years ago Gudernatsch carried on some stimulating and suggestive work upon the effects of feeding thyroid preparations to tadpoles. He was able by this means to greatly accelerate metamorphosis, causing a precocious development into the adult condition. It occurred to the author that since such precocious development was produced by an excess of thyroid material, an inhibition of metamorphosis might be produced by the removal of the thyroid gland. This is an extremely simple process, being accomplished by making a transverse cut just back of the thyroid gland, at the beginning of its development, in *Rana pipiens* tadpoles of 6.5 mm. total length. The tadpoles thus deprived of the thyroid gland developed in a perfectly normal fashion up to the time when the hind limbs began to grow. These limbs reached a length of four to five mm. and then absolutely ceased developing. This cessation of differentiation was not only seen in the case of the limbs, but was evident in the length of the intestine, characteristics of the mouth, the persistence of the tail, and the development of the skeletal system.

Fourteen thyroidless tadpoles were found to have retained their larval condition last September, while all of the control tadpoles had metamorphosed by the 13th of August. The thyroidless tadpoles continued to grow in size, but remained absolutely stationary in their differentiation. A study was made of the thyroidless tadpoles killed from time to time, and most interesting facts were gained.

One of my students, Mr. George Terry, made a study of the skeletal system, and found that the vertebræ and the bones of the limbs remained in that stage of development that they had attained when the frog ceased to show further signs of metamorphosis.

Another student, Mr. James Rogers, studied the effects of thyroid removal upon the thymus and pituitary glands. He found that the thymus gland in the thyroidless tadpoles continued to develop after it had ceased to grow in normal controls. The pituitary gland reached at least full size in the absence of the thyroid, and apparently grew even larger than normally. These glands are all closely interrelated, and the results thus obtained are of considerable interest.

The most interesting feature was the development of the gonads and germ cells. While the body as a whole remained absolutely stationary in its stage of development, the germ glands and germ cells developed almost normally. Ripe sperm were found in tadpoles killed December 15 and February 7. The ova continued their development until they were easily visible with the naked eye. A comparison with the germ glands of young frogs that had metamorphosed last summer, and had undergone normal growth, showed no higher degree of development than that found in these thyroidless tadpoles. It is true that the latter had gonads a trifle smaller than those of the normal frogs, but this is readily explainable upon the basis of the smaller size of the body. The gonads are proportionately as large in these thyroidless tadpoles as in the control frogs of the same age. It is most significant that of all organs studied, the germ glands alone have continued in their development.

This is very beautifully substantiated in a piece of research carried out during the previous year by Mr. W. W. Swingle, who under my direction studied the effects of thyroid feeding upon the germ glands of tadpoles of this same species. He

found that by feeding in the same way that Gudernatsch had done he produced the marked acceleration of metamorphosis mentioned above, but that the germ glands and germ cells remained unaffected, continuing their normal slow growth and differentiation. Here again we have an influence exerted on every organ except the germ glands.

I think we are thus justified in saying that the germ glands are not directly influenced by the thyroid gland. They neither show acceleration with the administration of thyroid nor retardation of development in absence of the thyroid.

Investigations were made upon the effect of removal of the pituitary gland of *Rana pipiens*. This was accomplished quite readily by making an incision across the front of the head and extending just beneath the pituitary gland. The latter was then easily picked away with a needle. As a result of this the tadpoles within eight days after the operation assumed a bright silvery color throughout, due to the migration of the black pigment cells from the epidermis, and to their marked contraction throughout the whole body. This was true whether these pigment cells were located in the skin or in the internal organs. Metamorphosis was prevented just as truly as by the removal of the thyroid gland. Owing to a very high mortality brought about by the absence of the pituitary secretion, it was impossible to study the later development of these tadpoles as might be wished. Enough is known, however, to enable us to say that metamorphosis is distinctly inhibited. This might possibly be explained by the failure of the thyroid gland to undergo its full development. Experiments are being conducted now to determine this question. There is no doubt that the absence of the pituitary gland caused the tadpoles to be very susceptible to unfavorable conditions. This could not be explained by injury produced, because many tadpoles that have been operated upon failed to show the equal change and continued to develop normally, reaching a size very much greater than that of the silvery tadpoles. When these normal-appearing tadpoles were sectioned it was found that the pituitary gland had not been removed in the operation, although the injury had been just as severe in these cases as in those in which the operation had been successfully carried out. There was neither a serious retardation in growth nor an appreciably large mortality. While both of these features were mainly

true in the tadpoles where the operation had been successfully performed.

These experiments will certainly lead to a very extensive series of other investigations of similar kind. A large and extremely fruitful field of research is opened up by this work.

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THE RELATION BETWEEN THE GERM CELLS AND THE ENVIRONMENT.

BENNET M. ALLEN.

THE constitution of the germ plasm is one of the most prominent questions before biologists. This problem has been attacked by the study of cell lineage, deformation, mutilation and chemical treatment of eggs before and after fertilization; by a study of the relation between egg and sperm in fertilization, and through it all have run the brilliant developments in the field of cytology and experimental breeding. We have thus come to understand some of the cardinal facts regarding the mechanism of heredity.

The individuality of the chromosomes; their occurrence in pairs; the sex chromosomes; sex-linked characters; the fatal results of multipolar division; the explanation of mutations upon the basis of chromosomal defects and mixtures—all of these results have been interpreted to show that the potentialities of the germ plasm are laid down in the *physical* structure of the chromosomes. But through all this work we have difficulty in estimating fact and theory at their proper value. This has led to our elevating theories to the rank of established truths. Many have come to believe that the germ plasm is aloof from the soma and absolutely proof against any changes that may take place in the environment.

Without allowing ourselves to dogmatize upon this subject, let us inquire into the nature of the relation between the soma and the germ cells.

In studying the early history of the germ cells of the vertebrates, I have been struck by the fact that they undergo an orderly migration from analgen, that are often remote, toward the regions where the gonads will ultimately develop. They appear to be guided and stimulated by influences exerted by the body cells. This striking migration of the germ cells re-

sembles the movements of pigment cells, and suggests the collecting of leucocytes toward points of infection. While most of the somatic cells of the embryo are syncitial during these early stages, the germ cells show sharp contours, and by their migration they must certainly break any protoplasmic bridges that may have united them with surrounding cells. It is, however, quite possible that new protoplasmic bridges may be afterward established. Color is lent to such a view by the relation of the follicular cells to the ovum in many vertebrates. Whether this be true, or not, there are intimate chemical relations between the germ cells and the soma.

The rapidly multiplying male germ cells, and the ova, with their enormous increase in size, demand large amounts of nutriment. Various other substances in the blood are absorbed into these cells, as demonstrated by Riddle in his experiments of feeding Sudan III to hens. If we assume that slight changes in the chemical constitution of the germ plasm might modify its hereditary tendencies, then it would be easy to understand that many changes in the substances carried by the blood, such as foods, drugs, waste products, internal secretions, etc., must exert a decided influence, because we should expect them to modify so complex and unstable a substance as protoplasm.

Unfortunately, we know but little regarding the nature of the changes that these substances may produce in the germ plasm.

These are the *a priori* considerations. What are the facts?

Certain external influences are found to produce deleterious effects upon the germ cells. Bardeen subjected the germ cells of toads to the action of X-rays, and found that while the fertilized egg started to develop, the embryos produced became more and more abnormal. Similar effects have been produced by radium.

Stockards' experiments upon alcoholized guinea-pigs show that poisons not only affect the soma but the germ cells as well, and that the injuries are manifested in later generations in weakened, defective individuals.

These effects are of a gross general nature and do not touch the question of the more subtle changes that may be produced in the germ cells by the action of external influences.

The striking experiments of Tower upon *Leptinotarsa*, of Klebs upon *Sempervium*, of MacDougal upon *Oenothera* and

Raimannia, and of Gager upon *Onagra*, have shown that various external influences, chemical and physical, acting upon organisms, can produce specific mutational changes in the germ cells, and that these changes remain permanent through future generations.

From these permanent modifications we may pass to a class of changes that are less fixed; that may be strengthened by long subjection to these influences until they become more and more definitely and permanently transmitted to future generations. The rather incomplete experiments of Woltereck upon daphnians represent such cases.

In other cases these influences may not originate characters, but are merely capable of determining dominance of one over the other when they are nicely balanced. Some of Tower's experiments upon *Leptinotarsa* show this. Recent experiments in the modification of the reproductive processes of daphnians and rotifers likewise illustrate this principle.

There is some difference of opinion regarding the nature of these changes; but it appears to be very definitely shown in the rotifers that parthenogenetic reproduction can be maintained an abnormally long time by exerting certain stimuli—food (Nussbaum and Mitchell), waste products dissolved in the culture medium (Shull), etc. These measures prevent the development of male-producing females. It has been shown that these are really sexual females, which, if impregnated, produced winter eggs that develop into females. Morgan, Shull, Whitney and others have urged that these influences determine whether there should be a parthenogenetic or sexual phase of reproduction; but as Mitchell has pointed out, this is a change from a condition in which regular parthenogenetic (unfertilized) eggs produced females to one in which eggs capable of being fertilized produced males in the absence of fertilization.

While these external influences are very potent when the egg is susceptible, it has been shown that they cannot overcome certain internal factors that make for sexuality in cultures that have passed through many parthenogenetic generations.

Equally striking results were attained by Woltereck in daphnians. He found that meager feeding, and, indirectly, temperature, tend to produce sexuality in these forms.

We may also point to the experiments in sex determination among amphibians as carried out by Miss King and by Richard Hertwig and his students. One difficulty with amphibian material is the long delay in sexual differentiation in certain strains. These very conditions point strongly toward sexual indifference which manifests itself in the hermaphroditic tendency to be observed in the toad. Is it not possible that the primitive germ cells, at least in these cases, may be truly indifferent? The differentiation that appears later might be brought about by the action of delicately balanced internal and external factors. Color is lent to this view by the fact that in many forms the secondary sexual characters develop in response to stimuli coming from the gonads, even when germ cells are entirely lacking in the latter. Why should we consider the differences between ova and sperm to belong to a category apart from the "so-called" secondary sexual characters?

In the minds of many the problem of sex determination is practically settled in favor of the sex-chromosomes theory. There seems now little doubt that this applies quite widely, if not universally, among the insects. While the presence of sex chromosomes has been demonstrated in many other types of animals, and the union of a sex chromosome with one of the other chromosomes in *Ascaris* has suggested that it may thus escape observation in still other forms where it has not been demonstrated, the fact remains that there are many forms where it has been most diligently sought without success.

In organisms where the sex chromosome is clearly demonstrable in each somatic cell, we should suppose that it could influence its cell in each case toward its respective line of sexual differentiation. For this reason we need not feel surprised to find in the experiments of Kellogg, Harms, Messenheimer and Kopec upon lepidopterous larvæ the clearest demonstration that the secondary sex characters in those forms are wholly independent of any influence from the gonads. This is in sharp contrast to the experiments upon representatives of most of the other types of animals, notably the vertebrates, in which the gonads exert a profound influence upon the body as a whole.

It is not contended that the importance of the gonad as an organ of internal secretion in a given species proves the absence

of the sex chromosomes. Both may be essential factors in this connection, in varying degrees of relative importance.

In spite of the highly critical attitude maintained toward the question of modification of the germ cells through influences from the environment, so much good evidence is accumulating that we cannot ignore these cases nor cry them out of court. While we can readily see how external influences acting upon the germ cells may so modify them that the offspring will be in some way influenced, it is difficult to accept, without more convincing proof, the experiments designed to demonstrate that characters acquired by the soma are transmitted to the germ cells in such fashion as to produce similar modifications in the soma of the offspring.

The experiments of Brown-Sequard, Kammerer and others, by which it is claimed that modifications such as injuries, changed instincts, changed color patterns, etc., are transmitted to future generations, have been so interpreted. It is so difficult to conceive of the mechanism by which these changes in the soma could be transmitted to the germ cells that we should demand far better proof than has thus far been brought forward; yet above all things, while we should maintain an attitude of skepticism, we should be free from dogmatic intolerance toward any really creditable work along these lines.

Much needs to be done in tracing out the effect of the environment upon fecundity and periodicity in reproduction. To what extent are these results attributable to modification of the germ cells? To what extent may these changes be inherited? While we have some data upon these points, as, for instance, in the case of sheep, the field is large and much needs to be done in it.

Domestication of animals introduces a whole series of complex factors involving change of food, modifications of climate, protection from the weather, modification or loss of instincts, etc. These all exert a profound influence upon the reproduction of animals. It would be difficult in most cases to say in how far selection might also play a part. We know that in many failures to breed wild animals it plays no part. Little has been done since the time of Darwin upon these important subjects. Our attention has been so closely fixed upon the study of the mechanism of reproduction that we have largely

neglected these problems concerning the influences that may induce modifications in it.

I predict that the study of the relations between the germ cells and their environment will yield some of the most important results in future biological investigations.

UNIVERSITY OF KANSAS, LAWRENCE.

LIFE CYCLES OF CERTAIN TREMATODES.

(Preliminary Paper)

Earl O'Roke.

PRELIMINARY studies made during the past two years show that fourteen species of larval trematodes, nine of which are new to science, occur in Kansas fresh-water snails. The accepted life cycle of the digenic trematodes is that the adult occurs in a vertebrate host, where it deposits its eggs. The eggs hatch out into ciliated free-swimming miracidia, which enter snails, undergo parthenogenetic development, and produce sporocysts, rediæ, and finally cercariæ, which are tailed, free-swimming larvæ. These cercariæ encyst in the water, and in that condition are taken into the digestive tract of their definitive host.

The widely varying conditions of infection in snails, the differences in the behavior of various species of the cercariæ, their failure to encyst in some cases and their peculiar habits of encysting in other cases, leads the writer to believe that the life histories, when finally worked out, will show variations from the accepted cycles. Perhaps some stages are omitted, or modifications added. The work is being pursued at Kansas University, where special aquaria have been fitted up for experimental determination of life histories.

University of Kansas, Lawrence.

THE DOMESTIC CAT A HOST OF THE DOG TAPEWORM, TÆNIA PISIFORMIS BLOCH.

J. E. Ackert and A. A. Grant.

THE ability of certain carnivore cestodes to develop in more than one host suggested the question, Will the common dog tapeworm, *Tænia pisiformis* Bloch, develop in the domestic cat (*Felis domestica*)?

Several kittens reared in cages covered with wire screen (eighteen mesh) were given *Cysticercus pisiformis* from the peritoneal cavity of the cottontail, *Sylvilagus floridanus mearnsii*, the intermediate host of this dog tapeworm.

In the experiment, three control and eight experimental kittens were used. When kittens 22, 23, 24, 25, 27, 29 and 32 were approximately six weeks old, feedings of cysticerci were made every few days until from ten (kittens 27, 29, 32) to approximately seventy-five cysts had been fed to each kitten. The examinations of these animals yielded the following results:

Kitten 27, examined two days after feeding, three tapeworms (length, 3.5 to 4 mm.) in the small intestine.

Kitten 29 (died), examined two days after feeding, eight tapeworms (length, 3.5 to 6 mm.) in the small intestine.

Kitten 32 (died), examined five days after feeding, five tapeworms (length, 6 to 10 mm.) in the small intestine.

Kitten 24, examined twenty-one days after first feeding, two tapeworms (length, 6 mm.) in the small intestine.

Kitten 25, examined twenty-two days after first feeding, three tapeworms (length, 10 mm.) in the small intestine.

Kitten 23, examined fifty-two days after first feeding, four tapeworms (length, 4, 5.5, 12.5, 22 mm.) in the small intestine.

Kitten 22, examined ninety-eight days after first feeding, no tapeworms.

Of the cestodes obtained from these kittens, two from kitten 23 were developed to the extent of having reproductive organs fully formed. The number and size of the rostellar hooks of all of the tapeworms obtained (twenty-nine), together with the double ovary, single median uterus, and prominent genital pore of the two larger specimens, agree so closely with the corresponding structures of *T. pisiformis* that these tapeworms apparently are of that species.

The control kittens, which were kept in the experimental cages, but not fed cysticerci, did not contain a tapeworm, while seven of the eight kittens that were fed *Cysticercus pisiformis* became infected with tapeworms, all of which agree with *T. pisiformis* in number and size of rostellar hooks, and two specimens agree so closely with this species that they are considered by the authors to be slightly immature specimens of *T. pisiformis* Bloch.

To ascertain in what part of the digestive tract evagination of the cysticerci occurs, kitten 26 was given ten of these cysts on the morning of July 24. Upon examination five and one-half hours later, four young tapeworms (evaginated cysticerci) were found in the posterior part of the duodenum, attached to its wall. The remaining six cysts were in the stomach still in the invaginated condition. Thus it is obvious that the evagination of *Cysticercus pisiformis* occurs in the duodenum of the young cat.

The larval form of this tapeworm develops occasionally in hares and in mice, but it is well known that its usual intermediate host is the cottontail. Considering the abundance of the latter and the large numbers of cats that have been examined for parasitic worms, it is evident that *T. pisiformis* rarely develops in the cat. However, this may be accounted for in part by the fact that after the young cottontail has eaten the tapeworm onchospheres, from six weeks to two months are required for the cysticerci to develop, and by this time the cottontails are usually large enough to evade the cat.

This cestode is sufficiently generalized to develop also in the fox, and Benoit-Bazille and Dramard[1] report it (under the name of *T. serrata* Goeze) from the tiger. On the other hand, evidences of specialization are not lacking. Several attempts to infect man have failed, according to Hall,[2] who ingested three cysticerci of this species with negative results, and Scott's[3] attempt to infect swine likewise failed.

1. Benoit-Bazille, H., and Dramard, J. 1905. Deux nouveaux parasites du tigre royal. Naturaliste, (2) 28:10.

2. Hall, M. C. 1914. Experimental Ingestion by Man of Cysticerci of Carnivore Tapeworms. Jour. Parasit., 1:5-9.

3. Scott, J. W. 1913. The Viability of Certain Cysticerci in Pigs and in Young Dogs Science, N. S., 37:263.

SUMMARY.

The dog tapeworm, *Tænia pisiformis* Bloch, may develop in the young cat (*Felis domestica*).

Evagination of *Cysticercus pisiformis* occurs in the duodenum of the domestic kitten.

Kansas State Agricultural College, Manhattan.

ADDITIONS TO THE LIST OF KANSAS COLEOPTERA, 1913 TO 1915.

WARREN KNAUS.

RECENT additions to the Kansas Coleoptera have not been especially numerous. The writer has collected only in the central part of the state. The annual summer collecting parties of the State University have accumulated much material, but it has not been worked out to a sufficient extent to determine the new things to be added to the state list.

The present list is due largely, as was the last list, to the monographic work of Maj. Thomas L. Casey, of Washington, D. C., who has issued Memoirs of Coleoptera Nos. V and VI since 1912.

The entire list of additions to *Pachybrachys* are due to the monograph of this genus recently issued by H. C. Fall, of Pasadena, Cal. His monograph has cleared up many disputed points in the genus. The species taken in this state can now be identified with reasonable certainty.

1. *Geopinus fluviatilis* Csy. Medora. June.
2. *Nothopus valens* Csy. Medora. June and October.
3. *Stenomorpha scolopax* Csy. McPherson. June.
4. *Harpalus lustrans* Csy. Dodge City.
5. *Stenolophus captiosus* Csy. McPherson.
6. *Stenocellus congener* Lec. McPherson.
7. *Stenocellus festians* Csy. Sedgwick county.
8. *Triplectrus ovularis* Csy. Salina.
9. *Chalcophora cupreolas* Csy. Kansas.

The above are from Memoirs of Coleoptera No. V.

10. *Rhombonalia comes* Csy. Cheyenne, Rooks and Trego counties.
11. *Anomala stigmatella* Csy. McPherson.
12. *Anomala modulata* Csy. McPherson and Lucas.
13. *Anomala saginatula* Csy. Kansas.
14. *Anomala medorensis* Csy. Medora, Onaga and Benedict.
15. *Anomala (Hemispilota) lucicola* Fabr. Kansas.
16. *Strigoderma quarternaria* Csy. Kansas.
17. *Strigoderma obesula* Csy. Medora and Hutchinson.
18. *Cyclocephala rufifrons* Csy. Kansas.
19. *Cyclocephala teunicatis* Csy. Douglas county.
20. *Ligyrus bicorniculatus* Csy. Kansas.
21. *Strategus (Strategodes) mormon* Burm. Medora. The writer took a pair of this very rare species, in May, 1913, in the sand hills near Medora. During the last season, 1915, eight specimens were

taken in the same locality. This is one of the largest and handsomest Scarabeids taken in the state, and is found in but few collections in the United States. Its range appears to be from Kansas to Texas, as the writer has a female specimen taken near Galveston, Tex.

22. *Euphoria herbacea* Oliv. var. Crawford and Bourbon counties.
23. *Euphoria* (*Haplophoria*) *clarki* Lec. Western Kansas.
24. *Euphoria (Haplophoria) wichitana* Csy. Wallace county. June and July.
25. *Euphoria* (*Haplophoria*) *texana* Schauf. West Kansas, from Nebraska south.
26. *Euphoria kansana* Csy. Manhattan.
27. *Euphoria cuprascens* Csy. Medora.
28. *Cremastochilus incisus* Csy. Kansas.
29. *Cremastochilus gracilipes* Csy. Cheyenne county.
30. *Cremastochilus* (*Trinodia*) *setosifrons* Csy. Clark county.
31. *Trigonopeltastes delta* Forst. Bourbon county. Taken summer of 1915 by the State University collecting expedition.
32. *Trichiotinus*, sp. near *T. affinis* Gory. Taken summer of 1915 by State University collecting expedition.

The above species are from Casey's Memoirs of Coleoptera VI, except Nos. 21, 22, 31 and 32.

33. *Pachybrachys arizonensis* Bow. Salina and Lawrence.
34. *Pachybrachys parvinotatus* Fall. Mead and Hamilton counties.
35. *Pachybrachys abdominalis* Say. Central and western Kansas.
36. *Pachybrachys diversus* Fall. All parts of the state.
37. *Pachybrachys sobrinus* Hald. Wallace, Salina, Medora.
38. *Pachybrachys impurus* Suffr. Onaga.
39. *Pachybrachys impurus umbrosus* Fall. Salina.
40. *Pachybrachys calcaratus* Fall. Salina.
41. *Pachybrachys peccans* Suffr. Medora, Mt. Hope.
42. *Pachybrachys postfasciatus* Fall. Douglas county.
43. *Pachybrachys vestigialis* Fall. Douglas county.
44. *Pachybrachys roboris* Fall. Salina.
45. *Pachybrachys tridens* Fall. Douglas county.
46. *Pachybrachys obsoletus* Suffr. Saline, Rawlins and Douglas counties.
47. *Pachybrachys liebecki* Fall. Medora, Hamilton and Clark Counties.
48. *Pachybrachys vittatus* Say. All parts of the state.
49. *Pachybrachys virgatus* Lec. Saline and Douglas counties.
50. *Pachybrachys dubiosus* Lec. Clark, Hamilton and Marion counties. June.
51. *Pachybrachys pawnee* Fall. Onaga, Medora, Saline and Wallace counties.
52. *Pachybrachys pallidipennis* Suffr. Fort Scott and Douglas county.
53. *Pachybrachys autolycus* Fall. Mead, Kansas; type, male. Also Medora, McPherson, Clark, Hamilton, Wallace, Douglas, Sedgwich, and Pottawatomie counties.
54. *Pachybrachys nigricornis* Say. Kansas.

55. *Pachybrachys carbonarius* Hald. Douglas, Pottawatomie and Wilson counties.
56. *Pachybrachys m-nigrum* Melsh. Kansas.
57. *Pachybrachys trinotatus* Melsh. Kansas.
58. *Pachybrachys luridus festivus* Fall. Type, a male from Salina.
59. *Pachybrachys instabilis* Fall. Kansas, in the Horn collection.
60. *Pachybrachys hepaticus* Melsh. Salina.

McPherson.

EXPERIENCE WITH AN OUTBREAK OF GRASSHOPPERS ON OVERFLOWED LAND IN LOUISIANA.

E. S. Tucker.

UNDER date of May 28, 1913, a planter of Oscar post office, Pointe Coupee parish, Louisiana, reported that great numbers of grasshoppers had appeared on his farm and other lands in his vicinity which had been overflowed by the Mississippi flood which had come through the Torras crevasse in the previous year. For several weeks past he had noticed the insects steadily developing in size, having been very small at first, but at the time of writing many had acquired wings. Although the adults, in company with the partially or nearly grown forms, still devoted themselves chiefly to weeds, yet some of both the mature and the young hoppers were invading the cultivated fields to such an extent as to threaten the crops by their attacks.

So numerous had they become in waste places that on being disturbed by the approach of a person their jumping out of the way shook the weeds and produced a sound like the patter of falling rain. Considering their menace, he wanted to know what means he should employ to check them from further attacks on his young corn. Another party, who telephoned from near the same locality on the 29th, stated that himself and the planters around him were alarmed by the hordes of grasshoppers which had damaged cotton as well as corn, though occurring only on land that had been covered by the flood of the year before.

In reply, instructions were given for preparing and placing poisoned bran as a bait and applying poison on weeds and cultivated plants, which practices have proved successful in other states. The directions were as follows:

To poison grasshoppers, make and use a bait composed of bran, 40 pounds; arsenic or Paris green, 3 to 5 pounds; molasses or cheap syrup, 2 gallons; water, about 2 gallons. Mix well and apply in rows along the line of advance, preferably along the fences where the insects congregate. Strew in a continuous row or in handfuls every few feet. Grasshoppers seldom feed after partaking of this mixture, but they may not die so as to be noticed much less than two or three days later. Poison may be dusted on the weeds where the insects are thick, but it should not be applied at full strength on corn or other growing crops, as it will burn the plants. Be careful of stock and poultry.

On June 7 following, the first party wrote that he had failed to get any effective results from the methods as recommended, and he requested that a personal inspection be made. He emphasized his appeal by stating that his section of country was in no shape to stand any further loss of crops, and he feared that unless something could be done promptly in order to stop ravages of the grasshoppers the crops would otherwise be entirely destroyed. While stating that a large number of the insects had not reached maturity, he declared that they had already done considerable damage by completely destroying small cotton plants and injuring all young corn. Owing to the repeated plantings of his cornfields, which had been necessitated by failure of the sprouts due to infestation by the southern corn rootworm early in the season, most of the stands were still in a tender stage of growth, being late and not very high.

By appointment, with the object of rendering all possible assistance in the matter, a visit was made by the writer on the next day. On arrival by train at Oscar station on the Frisco railway a neighbor at once directed attention to the cotton fields on his plantation, situated a short distance south of the railroad. In the first field that was visited the grasshoppers were found to have invaded it in scattered numbers from the weedy bank of a shallow bayou. They had destroyed many plants and eaten away portions of the foliage on most of the remainder of the stand throughout the adjoining half of the field. Their ravages were also noticeable beyond the middle part, even extending close the oppsite edge. The loss of stand was greatest in a sunken spot where the plants had barely put out their first leaves. On account of the small size and tender nature of these leaves, the grasshoppers had completely defoliated quite a number of the sprouts, and in several instances had also gnawed the stems.

While the ratio of dead and dying sprouts was not very large in comparison with the number of living plants, yet the surviving growth showed that it could easily be killed or at least suffer a serious backset if the ravages increased, because a considerable amount of foliage had already been consumed. Nearly every plant had one or more grasshoppers resting upon it. On observing that the majority of the grasshoppers in the field were winged adults, some apprehension was felt that fur-

ther additions to their ranks would be effected just as fast as the young forms attained maturity in the weeds along the bayou, where they abounded in multitudes. The destructive effects of their voracious feeding were seen on nearly all of the wild vegetation, and many of these unfleged insects had actually encroached on the cotton plants standing close to the weedy border.

Of the two different measures that were being tried out here with the object of thwarting the insects, one consisted in the scattering of poisoned bran along the outer edge of the weeds, next to the field, according to the directions that had first been advised by letter; and the other treatment proved to be nothing more than an application of plaster of Paris to the cotton plants. The idea of using the latter substance had been proposed by the owner and carried out by his instructions. Since no dead grasshoppers could be found around the heaps of poisoned bran, and neither had any of the insects been known to feed on or pay any attention to the mixture, the trial of this preparation was therefore considered to be an absolute failure. But the plants that had been dusted with plaster of Paris, this having been first applied about a week before, presented a nearly perfect condition, though a very slight coating of the plaster remained on them. Few grasshoppers were seen on plants more recently treated with the plaster, but none of them could be detected in the act of feeding.

Results seemed to show that the latter treatment had some merit by preventing attacks after the application had been made. The plaster merely appeared to deter the insects from eating the coated leaves, as no evidence of any dead or dying hoppers came to notice anywhere. Its application on just a few rows of the plants covering but a short distance into the field was not sufficient to afford a conclusive test, yet the advantage which it gave, while the poisoned bran had proved useless, had to be acknowledged. Being an admirable sticking medium, its use might have been made more practical with less quantity per plant, and with the addition of Paris green at the rate of one part to fifteen times the amount of plaster, or in the same proportion as when the poison is used with lime. Either of these mixtures can be applied with safety to field plants. Mention might be made of another benefit rendered by the use of plaster, which is its fertilizing value to the soil after it becomes deposited on the ground.

Inspection of other cotton fields bordering the bayou disclosed the fact that the ravages committed by the grasshoppers were far less severe than in the first field, the damage being mainly confined to plants standing nearest to the heavily infested weedy banks. These observations tended to modify the prospect of a very serious situation with respect to extent of injuries. Nevertheless the hordes of young hoppers occurring in the weeds were looked upon as presenting a threatening attitude of danger, owing to their liability to spread into the fields, particularly on acquiring wings. Altogether the owner claimed that he had lost from his stands of cotton enough plants to cover eight acres.

On visiting the farm of the planter who first called for assistance, whose place adjoined the town of Oscar, situated at a distance of several miles in a northeasterly direction from the station on the railroad, the grasshoppers were found to be swarming in the weeds on roadsides, along ditch banks and fences, and throughout weedy areas extending over hundreds of acres of surrounding uncultivated fields. All of the country that had been overflowed was said to be similarly infested with the hoppers, this assertion being sustained by the statements of neighboring planters who had gathered for a conference.

The conditions on this place were declared to be fairly representative of most plantations in the district. With one or two partial exceptions, none of the planters had ever before experienced such an occurrence of the insects.

The invasion of fields with growing crops was looked upon with considerable alarm, particularly as the depredations committed by the insects on corn had already caused a general ragged appearance of the leaves, as was observed in the immediate field. Cowpeas that had started to grow between the corn rows were being rapidly consumed. Many of the grains on the heads of maturing oats plants, also growing on the plantation, were found to be gnawed and ruined, and the growth of lespedeza, which had gained a good start following the oats, was being fed upon to a perceptible extent. Despite the abundance of the grasshoppers in the latter field, the pests seemed to prefer the weeds rather than the crop plants, yet the problem remained to be faced as to what amount of harm the insects might do to the lespedeza after the harvesting of the oats, when the weeds would likewise be cut. In a

field of cane just a few leaves of the plants in the outer rows were observed to be attacked, and only to a slight degree.

As stated before, the planter had failed to get any effective results from the placing of poisoned bran at the edges of weedy margins of his fields, and neither had he found any dead hoppers in the weeds where he applied Paris green and lime, these materials having been mixed at the rate of one part of the former to fifteen parts of the latter.

After returning to Baton Rouge on the following day the writer advised the station director respecting the injuries and further danger of attacks due to the myriads of grasshoppers, against which the attempts to check their invasions into the cultivated fields had proved ineffective. A decision was reached to appeal by telegram to the Federal Bureau of Entomology for coöperative assistance in an effort to determine some practical means of protecting the crops from ravages by the insects. In prompt response, Mr. J. L. Webb, an agent stationed at Crowley, La., came to the vicinity, where he was joined by the writer on June 14. Under Mr. Webb's direction, just previous to joining him, a quantity of Criddle mixture had been prepared and exposed in open places along the edge of cornfields on the planter's land.

After making a tour of the fields together, we concluded that the attacks by the grasshoppers were not extensive enough to excite fear of very serious damage to the crops, since both cotton and corn generally appeared to be growing ahead in spite of depredations. Most of the surviving cotton plants which had sustained the brunt of attacks in the edge of fields on the distant plantation situated south of the railroad gave promise of putting out a leaf expansion in excess of what would likely be devoured by the hoppers that were still observed to be busily feeding on the growth, though occurring only in scattered numbers. No marked increase in the numbers of invading insects was noticeable. The plants that had been treated with plaster of Paris seemed to have escaped further damage, except in some cases where stems had been gnawed.

Although the effects of depredations on corn were quite marked throught the fields, being most severe at the edges, yet the attacks has caused little harm to the growth other than the impairment of the lower and middle blades, which

even at the worst had suffered but partial loss of tissue. Since the hoppers showed scarcely any disposition to advance very high upon the stalks, the formation of tassels on the older growth was apparently safe from attacks, and so far as the silk had put out, none of the insects appeared to be attracted to it. However, in pointing out the possibility that the pests might eat the silk even should they spare the tassels, and therefore interfere with the fertilization or development of ears, their operations in such an event would result in a reduction of the yield, since ears so affected would be stunted and mature as nubbins. Yet few individuals occurred on any single plant, and practically all of the hoppers in the field appeared in the winged stage, some of which were found pairing.

Examination of the places where poison mixture had been applied afforded very little encouragement for the attempts so far undertaken to use baits. The Criddle mixture proved to be as useless as poisoned bran. However, in weeds that had been dusted about two weeks previously with Paris green and lime, at one to fifteen parts proportionately, several dead hoppers were found lying on the ground at various short distances from one another, but no appreciable difference had been effected in the abundance of the living ones which still infested the area. The finding of other dead bodies at more frequent intervals near a heap of poisoned bran in the same place indicated that a slight mortality of the hoppers had been caused by some individuals feeding on the mixture. This evidence was all that could be obtained to denote that the pests had fed on the mixture in any situation.

On the following morning applications of powdered arsenate of lead in different amounts were made on both weeds and corn with the object of determining the efficiency of this poison according to dosage. Considering the labor and cost of material, in order to do effective work in suppression of the insects, we decided that such expenditures would evidently amount to more in value than the losses which might befall the crops, and consequently no prompt means of fighting the pests to a sufficient extent could be made economical. Our departures being hastened by other pressing duties, Mr. Webb left in the afternoon for return to his station, while the writer accompanied him as far as Livonia before turning back to Baton

Rouge. At Livonia the writer learned that although plenty of the grasshoppers occurred in the locality and had attacked corn, the farmers were not alarmed about them.

The results of the last treatments made before our departure from Oscar were reported by the planter in a letter written on the 19th, in which he reviewed the whole situation, saying as repeated herewith:

Director W. R. Dodson, Experiment Station, Baton Rouge, La.:

DEAR SIR—At the request of Mr. Tucker, who recently visited this section and made some experiments in an effort to poison the grasshoppers now very prevalent and destructive here I beg to submit the following:

The first poison used was Paris green, with one part poison to fifteen of air-slacked lime. This had no effect other than to kill some of the vegetation and a very few hoppers, but not enough apparently to reduce their numbers or to drive them away from the patches to which poison had been applied. Then poisoned wheat bran was used after a formula furnished by Mr. Tucker. This had no effect whatever, as the hoppers did not eat it. Then under the direction of Mr. Tucker and Mr. Webb, of the U. S. Department of Agriculture, a mixture of horse manure, salt and Paris green was placed in the field where the hoppers were most plentiful. Like the bran mixture, it would have been fine, only the hoppers would not eat it. Then pure arsenate of lead was applied to weeds and crops in quantities ranging from normal field conditions of three to four pounds per acre to perhaps fifteen or twenty pounds and at a prohibitive cost for labor and time. Under normal field conditions the applications produced no effects whatever, but the heavy applications damaged the corn plants a little and killed very few hoppers, not enough, however, to make any appreciable decrease in their numbers.

The hoppers seemed to have hatched out in lands that were overflowed last year and which were not cultivated this year. On my farm that means only ditch and bayou and roadsides, but there are many hundreds of acres of land surrounding me that are not in cultivation and that have produced enormous numbers of hoppers. Up to now, however, they are not migrating to any great extent, but are eating along the edges of the fields near which they were hatched. The damage done to date is not great to corn, but cotton has suffered considerable damage and yesterday I noticed them eating all of the silk from the ears of corn in the rows near the ditch banks, etc. This I believe means that we will make a good shuck and cob but no grain on the ears so damaged.

I thank you and your assistants for your efforts to help us in the matter, but must say that the results so far have been only negative ones. We have learned some of the things that will not work.

THOS. H. HEWES.

Throughout all of the observations carried on by the writer, rarely was a small bird seen on the infested lands, where, with such an abundance of insects, flocks of our so-called feathered

friends, if inhabiting the country at all, would naturally have been expected to congregate from miles around to feast on the grasshoppers. In reality, not even the few birds that did show themselves in the fields appeared to pay the least attention to the hoppers.

Though the efforts so far made for repression of the pests had proved to be of little avail, the facing of this situation still left hope for a resort to other measures. Considering that reoccurrences of the grasshoppers in destructive numbers might be possible during the following year or two, if not longer, unless some practical means could be applied to check any outbreak, an appeal was again referred to the Federal Bureau of Entomology, proposing the introduction of a fungus disease, providing this plan would be considered feasible. This proposition was based on the fact that the fungus under favorable conditions has attacked and killed grasshoppers in trials made of it as reported in the publication cited farther ahead. The matter, however, did not reach the attention of the chief entomologist, Dr. L. O. Howard, until July 18, when he wrote that he had requested Dr. John R. Mohler, of the Bureau of Animal Industry, to send a tube of culture of the South African fungus. Doctor Howard remarked that, "Possibly, in the moist climate of Louisiana, the fungus will be of some effect."

At the time of receiving the culture, on August 4, word had come to hand from Mr. J. L. Webb stating that the planter had recently written that his corn had not suffered greatly from the grasshoppers, which, in fact, had mostly disappeared. Yet a visit to the locality was planned for the purpose of making an immediate trial of the fungus in case enough insects would be found to justify an introduction of the disease. The manner of procedure was adopted in accordance with directions given in an article entitled "Experimental work with fungus diseases of grasshoppers," by Dr. L. O. Howard, appearing in Yearbook of the U. S. Department of Agriculture, for 1901, pp. 459-470.

After preparing the culture on the morning of August 6, and keeping it in a warm place until evening, it was then corked in a wide-mouthed bottle and carried in this way to the field on the following morning. However, no growth of the fungus had appeared on the floating corks, but its absence was thought to be due to agitation of the contents produced by carrying the

mixture about. Owing to a comparative scarcity of the grasshoppers in the fields—which condition afforded an astonishing contrast with the former abundance of the insects—only a few individuals could be collected in a weedy and grassy corner of the planter's field, where a stop was first made in search of a thickly infested place in which to apply the infection. While the slight occurrence of the insects here offered a scant prospect for a successful introduction of the disease, the captured specimens were nevertheless dipped in the infected solution and then released.

On driving farther into the back fields and finally reaching a weedy area adjoining the bank of a bayou, where the grasshoppers had formerly abounded in the most teeming swarms, a considerable number of adults were found remaining there. Being fairly numerous enough to offer a good chance for the spread of disease among them, several dozen of the insects, belonging to different species, just as they occurred, were caught, dipped in the infection, and released in a course surrounding the rankest and most heavily infested vegetation.

Why the pests had become so reduced in numbers could not be definitely explained, but the supposition may be ventured that they had normally fulfilled the functions of life shortly after attaining maturity, and then perished, leaving their deposits of eggs to hatch out into new broods during the succeeding spring. The planter stated that the reduction in numbers began soon after the time of the writer's last visit in June, and since then the hosts had steadily diminished. He also remarked that if the fungus had been applied at about the time when the hoppers became less numerous, one might easily have believed that the disease had caused them to die and disappear.

General observations made on this visit in regard to the condition of crops showed that no additional damage had been done by the grasshoppers beyond what had resulted from their earlier attacks as previously mentioned. While much silk had been eaten off from the ears of corn, no appreciable stunting or lack of development of the latter had yet come to notice. Although all of the growth was still green and had many ears with fresh silk, the grasshoppers had completely deserted the fields and could be found only in the weeds outside. A great shortage of cowpea growth, however, proved to be a matter of the most concern. Early planted cowpeas had suffered se-

verely from the inroads of the grasshoppers, nearly all vines having been destroyed over a wide distance along the edges of the field. A later planting of the same kind in another field of corn had been almost entirely devoured on the appearance of the first leaves. The lespedeza had escaped material harm, and all the cotton that was seen in the vicinity presented no sign of molestation by grasshoppers.

In an interview with another planter at Mix post office, he said that the early ravages of the grasshoppers had caused the loss of fifty acres of cotton and about the same acreage in cowpeas, but otherwise his crops had grown right ahead and now promised good yields. At the present time not very many of the insects remained on his lands. He recalled a similar occurrence of the pests following a flood of several years before.

Regarding the use of the fungus, however, the results turned out disappointingly. The weather directly following the first introduction made by the writer, on August 7, was occasionally rainy, but the latter part of the month brought a dry spell. The planter was requested to report on the outcome, and kindly did so on August 28, writing as follows:

"I kept the culture you left with me for a day or two until it developed the mold which you predicted would appear on the corks. I then took it to the fields and applied it to a number of grasshoppers, being careful to select some of each kind. As you know, the grasshoppers are very scarce and tests made under such circumstances are unreliable. I have made since that time serveral searches and found no dead specimens. There are now very few live ones. I regret being unable to give you more definite information. I have also searched the places where you applied the culture and found no dead hoppers."

For the purpose of correcting a certain misunderstanding, an explanation should be included here. Through a news correspondent, a wrong impression was unfortunately circulated concerning the use of plaster of Paris on cotton plants. This misrepresentation led to the following inquiry being made by the agriculturist of a large southern railway system. Only the essential parts are quoted, with modifications.

LITTLE ROCK, ARK., June 21, 1913.

I have seen an item in a New Orleans paper stating that a party of Oscar, La., has been successful in destroying grasshoppers and boll weevils with plaster of Paris. It is also stated that the effect of this substance was superior to that accomplished by a preparation advised by the State Agricultural Department in destroying grasshoppers. Do you know anything of these demonstrations, especially if this substance

has shown any merit as a destructive agent against the boll weevil? Personally I cannot see how anything could be accomplished with it, but thought possibly I might be mistaken in my conclusions. Any information you can give me regarding the matter will be appreciated.

Answer was made to the above that observations on the use of plaster of Paris for protecting cotton from grasshoppers were not sufficient to be conclusive. Boll weevils did not come under consideration at all since none were seen in the fields owing to the land having been overflowed during the year previous. The actual facts in the case were given in order to make the matter clear, emphasizing the point that the problem of suppressing the grasshoppers was not yet solved.

The prevailing species in the outbreak proved to be the common redlegged grasshopper, *Melanoplus femur-rubrum* DeG. When first observed, on June 8, this insect occurred chiefly in the unfledged stages. The youngest form had then attained to a growth seldom measuring less than one-half inch; the nymphal stage varied from five-eigths to seven-eigths inch in length. The adult males averaged about three-fourths inch in length of body, or one inch to tip of wings, and the mature females slightly exceeded the males in length. Great numbers of the insects had reached the adult stage on June 14.

The short-winged species, *Paroxya hoosieri* Blatch., was rather commonly associated with the red-legged grasshopper, appearing as nymphs on June 8 and as adults on June 14. These two species were identified by Mr. A. N. Caudell from a collection submitted by Mr. J. L. Webb.

Specimens of *Chortophaga viridifasciata* DeG. in adult form were occasionally found on June 14 and August 7. Also, examples of the following katydids were seen to be scatteringly dispersed among grasshoppers: *Scudderia furcata* Brunn., adults taken June 8; and *Conocephalus fasciatus* DeG., both nymphs and adults on same date. These determinations were furnished later by Mr. A. N. Caudell.

Agricultural Experiment Station, Baton Rouge.

NOTES ON THE GREEN BUG (TOXOPTERA GRAMINUM ROND.) IN TEXAS.*

E. S. Tucker.

THE following notes relate to the writer's first experimental work in Texas, which consisted of an investigational study of the green bug (*Toxoptera graminum* Rond.). Under appointment as entomological field assistant, the project was entered upon on May 6, 1907, and prosecuted until the end of the year, at Plano, Collin county.

As a result of the sweeping outbreak of the green bug earlier in the year, the grain growers of northern Texas in particular, which country comprised the principal grain-producing section of the state, had suffered almost complete loss of their prospective wheat and oats crops. When the seriousness of the devastations first became apparent the grain dealers met and appealed for assistance towards determining measures for future control of the pest. In response the Texas Agricultural Experiment Station authorized an investigation, the means being provided by an Adams fund apportionment. The arrangements included the fitting up of a field station at Plano, for which the grain dealers rendered financial aid that deserves grateful acknowledgment. The locality is typical of the black prairie region on northern Texas, and up to this disaster grain growing had been carried on here extensively.

At the time of the writer's arrival on the scene only a very slight percentage of the early grain acreage had been spared with any prospect of making a fair yield, the ravaged fields generally having been plowed and planted to corn or cotton. On account of a change of natural conditions, as explained later, the season proved very unfavorable for a proper study of the green bug, especially regarding its summer habits. The present notes, however, deal only with matters aside from the serial breeding of the insect. All records which contained the main results of work have since been unfortunately destroyed by fire.

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* Published by permission of Prof. B. Youngblood, director of the Texas agricultural experiment station, which instituted the work.

THE SPOTTED LADYBIRD-BEETLE AS AN ENEMY OF THE GREEN BUG, AND A STATEMENT OF FIELD CONDITIONS.

Comprising a part of the investigation experiments were begun in July for the purpose of determining the efficiency of the spotted ladybird beetle (*Megilla maculata* De G.) as an enemy of the green bug. This ladybird which together with its associated relatives was more ordinarily but less becomingly called ladybug by the farmers, appeared to be the most common and consequently the best known of its family occurring in northern Texas. In the country about Plano the adults of this species alone, without considering the larvæ, were the most conspicuous and abundant of all beneficial insects observed in the wheat and oats fields during May and June.

The other inimical insects were chiefly *Scymnus loewii* Muls., *Hippodamia convergens* Guer., and *Chrysopa plorabunda* Fitch. Previously the aphid parasite, now known as *Aphidius testaceipes* Cress. (Formerly *Lysiphlebus tritici* Ashm.), being reported by Prof. C. E. Sanborn, who had watched the fields from the start of the outbreak, had played an important part in reducing the green bug to the point of extermination, and then had vanished suddenly itself. Its absence, therefore, precluded it from further consideration. Besides, owing to the scarcity of the green bug, which at last completely disappeared soon after the middle of June from under observation in the fields, the stock for experimental purposes was necessarily bred on oats and wheat seedlings in pots and cages. However, other grain aphides, principally *Siphocoryne avenæ* Fabr., survived sporadically in the fields in spite of the different ladybirds and associated predators, and subsided upon the plants until their nourishment failed, whereupon a marked development and dispersion of winged migrants took place.

In the expectation that a similar development would occur with the green bug, so it might be enabled to reach other host plants for the summer, preparations were made for subjecting a number to the same field conditions by stocking tight muslin-covered field cages with introduced colonies. But as the grain plants had already begun to dry and turn yellow at the time, the bugs failed to thrive long enough for any noticeable change to take effect. If the experiment had been started earlier, while the field plants were succulent, so as to have allowed the

bugs an opportunity to breed abundantly and establish themselves thoroughly, the trial would have afforded better chances of success. The delay in making preparations was caused by the failure to receive the cages in proper time.

But in considering the spotted ladybird, the changing conditions brought on by the maturity of the grain crops seemed to cause this insect scarcely any concern until the general drying of the plants had practically resulted in an obliteration of the usual dependent pests. The individuals then began to hunt in a leisurely movement for a fresh food supply, and naturally concentrated in the last failing green spots and edges of the fields, where they apparently obtained a precarious subsistence temporarily. They were by no means clear of the fields when the crops were harvested in the last week of June and first week of July, but at last the barren stubble enforced their complete dispersion. After lingering for a few days in the weedy edges, the last straggling beetles finally disappeared, and scarcely any trace of the species could be detected anywhere during the remainder of the summer. The reason for such scarcity of this insect seemed to be clearly due to the lack of suitable prey, especially since none of the former pests of the grain fields, on which the beetles doubtlessly depended for feed, appeared in any other situation covered by exhaustive search.

Although the spotted ladybird is not considered a distinctive aphid feeder by all authorities, it nevertheless thrived well in confinement upon a diet of green bugs, but at the same time manifested cannibalistic tendencies to devour its own eggs. Its life and behavior under these conditions were carefully observed and the particulars noted.

Female beetles in confinement deposited eggs in clusters containing altogether at a laying, so far as observed, from seven to thirty eight eggs. These eggs were characteristically cemented endwise upon the surface of the glass jar used for cages. A single cluster, whether comprising the whole or only part of a laying, seldom contained as many as fifteen eggs. Whenever a larger number was laid at a time the eggs were usually deposited in separate small clusters.

Whether the disposal of eggs in such manner is designed by the mother ladybird as a precautionary measure for the benefit of her young, thereby indicating a maternal concern, is an interesting question, since the corresponding separation of

small groups of larvæ consequent to the hatching of the eggs would reasonably be expected to afford an important advantage to the young under natural surroundings by preventing an extreme preponderance of them on one plant or part of a plant, where if all issued in a mass they would be confronted with a proportionate competive risk of finding live prey not only ready at hand but also in sufficient quantity. Inevitable as the risk must be in any case, yet the larvæ, which at first are almost helpless creatures, have an opportunity to prepare for the critical occasion of obtaining prey, though only in a feeble way at the best, but which is still highly essential for their welfare.

In support of this conclusion, the conduct of those in confinement has furnished evidence to denote that live prey is not immediately demanded, because the newly hatched larvæ first partook of their egg shells and made no effort to seek further food for at least a day afterward. Obviously their future career depends at this juncture upon finding a fresh food supply within convenient reach, and not to exceed, at the most, any short distance to which the tender young larvæ may be able to wander.

Even in instances concerning those under observation, the larvæ failed to sustain themselves, although they were inclosed in a small jar with an abundance of live green bugs on fresh blades of grain which lay on the botton within a few inches, or at the most not farther than four inches, of the larval birthplace; and besides, the green bugs frequently crawled close around the spot where the larvæ rested. As to the death of these larvæ, no definite cause could be ascribed otherwise than to starvation as a result of natural weakness that incapacitated them from obtaining live food, although as a possible factor in imposing a devitalized state, consideration was given to artificial breeding conditions. But in view of the fact that other larvæ succeeded vigorously, the effect of confinement could not have been of material consequence; and furthermore, the usual outcome would discredit any question of objection to the kind of prey. Of all reasons considered, the intensely hot weather at the time of these failures might have exerted the real detrimental influence.

The probable importance of distribution, first in small groups and later by scattering of individuals, is a point to be

deeply considered as affording several chances in different places whereby some if not all of the larvæ composing an issue may succeed in overtaking the prey. This feature might serve to prime advantage, particularly during a time of food scarcity, by saving an issue from utter failure, which would more likely be the case if the entire number of larvæ issued forth all together in one place rather than in small groups at separate places. For if one spot should be destitute of prey, another might happen to be propitious. Without the support of positive evidence concerning the larval relations in nature, any discussions on this line must necessarily be very incomplete, but the following remarks are introduced as a summary of conclusions.

At the time a young larva ventures upon the active course of its life it is still a frail creature. Its strength is hardly yet sufficient to enable it to wander far in search of food or to withstand much hardship. On account of its own weakness and the hazardous conditions to be faced in nature, its chances of passing not only the most critical period of its life when it starts out into activity, but of its entire course, cannot always be promising. Furthermore, it is liable to suffer from competition with its fellows at the start, but only in a limited degree, since the primary demands are slight. With gain and growth in strength, gradual separation of individuals occurs, and without doubt lessens the danger of competition, which may eventually be reduced to insignificance or be entirely eliminated by extensive scattering of the older larvæ.

The time of development from a freshly laid egg to the maturity of an adult ranged from 16 to 20 days, in periods as follows: for hatching of egg, 2 to 3 days; for growth of larva, 10 to 12 days; and for pupation, 4 to 5 days. The particulars of the nearest complete records of development are shown by the following two cases:

Eggs laid.	When hatched.	First molt.	Second molt.	Third molt.	Fourth molt.	Pupation.	Maturity.	Total time.
Aug. 13	Aug. 15	Aug. 18	Aug. 19	Aug. 21	Not seen	Aug. 25	Aug. 29	16 days.
Aug. 23	Aug. 26	Aug. 28	Aug. 30	Aug. 31	Sept. 2	Sept. 7	Sept. 12	20 days.

The number of green bugs consumed by the ladybird larvæ during their period of growth was determined by actual count,

taking old and young *Toxoptera graminum* just as they occurred on oats and wheat seedlings and supplying them to these young *Megilla maculata*, each being separately confined. The counts were made promptly at the beginning and end of each daily supply, and the missing number of green bugs in each case was reckoned as the actual consumption by the ladybird larva for the day. The entire results are herewith recorded:

Days.	1	2	3	4	5	6	7	8	9	10	11	12	Total.
Larva No. 1	....	....	....	19	26	28	26	63	32	70	58	end	322
Larva No. 2	....	....	8	31	10	19	28	49	65	80	30	end	330
Larva No. 3	....	7	1 7	18	10	37	39	41	93	99	103	43	497
Total combined	....	....	....	....	....	....	....	....	....	....	....	....	1,149

As the first meal of the larvæ consisted of their own egg shells, they did not commence to feed upon a supply of green bugs until one or two days after hatching, and in some cases longer. By simply transferring the larval ladybirds from one jar to another containing each supply of green bugs, no confusion could occur about the separate allotments.

In the same manner as was pursued with the larvæ, the feeding capacity of a pair of adults in confinement together—male and female, which matured from the reared larvæ—was determined for a period of 40 days, or from August 29 to October 7, in which time, 3,804 green bugs were devoured by them, thus accomplishing an average daily destruction of 95 green bugs. These figures show that a single adult ladybird is capable of eating approximately 50 green bugs every day. These two beetles were still alive at the end of December, when the work ceased, but they had become dormant on the approach of cold weather, and therefore very clearly indicated an aptitude for passing the winter in a true state of hibernation.

At no time throughout the experimental test did these ladybirds lack an abundant supply of live green bugs. Every apportionment of such food was provided somewhat in excess of the amount which the beetles really consumed within the duration of the allowances, in order that the insects might be tempted to feed to their utmost capacity. In the treatment of the larvæ the food supply was furnished every day for the purpose of keeping an exact daily record: but with the adults a reckoning of the amount of their consumption was not always

made with the same regularity, and sometimes included two days without the need of a fresh change to maintain a degree of enticement.

Despite these ample provisions, the female ladybird repeatedly ate her own eggs, and the male in a few instances was also observed in the same act. If the insects were free in nature such cannibalistic tendencies might be obviated in a great measure on account of the insects being at liberty to rove, but otherwise the quantity of prey consumed would very probably in most cases be considerably less than what the experimental deductions show. Only during extreme infestation of fields could prey be found as available and constant in volume as would compare on an equal basis with the supply furnished for the experimental tests, with the difference, of course, of no expenditure of energy being required on the part of the ladybirds for hunting in small imprisoned spaces. In restricted confinement the beetles could not fail to find the supply of food provided for them, whereas in freedom they would be apt to meet with uncertain or irregular provision, owing to the variable occurrence of prey. Even in time of abundant spoil the roving disposition of the ladybird may possibly lead many individuals far astray from the areas of infestation. The prospect of decimation appeared most perilous during midsummer, which may be regarded as the prevailing period of seasonal adversity, for in this interval the natural restriction of prey subsequent to the maturity of the small grain crops certainly reacted with disastrous effect on the spotted ladybird.

One serious fault to be found with the spotted ladybird, if not also applicable to many of its relatives, as was learned from observations regarding its attention to aphid prey in the fields as well as in confinement, is the evident fact that it is a vacillating hunter. Its movements are decidedly erratic and therefore too variable from any proper course to be fully effective in overtaking prey to the best advantage or wherever the latter might occur most numerously. Hunting in a random sort of way, the beetle seems to miss the greater share of prey in any general path which the individual pursues, and one may even brush past a particularly infested plant without showing the least concern.

Still effective work by it may be possible in case that a sufficient number of beetles abounds so one might chance upon what prey another has failed to find. Its faculties for de-

tecting the prey seem quite inadequate, because the beetle has been seen time after time to run directly over or even dislodge many green bugs or other aphides from their positions on the blades of plants and not exhibit any sign of perception of these objects. Only when a ladybird happens to run its head against an aphid, so that the mouth parts or palpi come into contact with the body of the prey, does the beetle appear able to recognize the presence of a victim. Since the beetle wanders from leaf to leaf in a hasty manner, making but brief pauses at various distances, it actually runs over numbers of aphids and needlessly sweeps them off of its path by the gripping motions of its legs. The aphids which fall to the ground upon being dislodged from a plant by the movements of a ladybird when it traverses a blade have a chance to crawl back on the same or another plant and reëstablish themselves.

Another faulty trait to be charged against the spotted ladybird, and in particular to the larva, is accountable to the insect's fondness in feasting on wingless green bugs in preference to the winged forms. Unless a ladybird should likely be very hungry, the winged green bugs are liable to be spared for choicer morsels as presented by the apterous forms. Possibly the migrants can ofttimes make their escape on the approach of a predaceous foe, especially if it should be a clumsy ladybird.

On the whole, the importance of all the useful ladybirds is obvious, and a recognition of the various kinds in their different stages will enable the agriculturist to avoid mistaking and heedlessly destroying them as supposed pests, when instead they should be treated with friendly regard and afforded every possible protection and encouragement for the valuable service they render.

BREEDING FACILITIES IN WORK WITH GREEN BUGS.

For isolated breeding of *Toxoptera graminum,* a sufficient number of pots in which food plants have to be grown is an essential requirement. A special type of galvanized iron pot with a capacity of about a peck measure, and having a tube connected on the outside for conducting water as needed into the earth contents from beneath the surface, was used with much satisfaction. Common earthen flower pots answer admirably, and even ordinary tin cans were utilized on emergencies.

Glass chimneys or globes were used for enclosing the plant after a green bug had been isolated upon it, and as a further measure of protection against accidents or enemies, the top of the chimney was covered with a piece of muslin cloth held tightly in place by a rubber band. Although care was taken to set each chimney firmly in the earth, yet rats and mice occasionally succeeded in digging under the base and thus gained access to and destroyed the seedling, usually causing the loss of the isolated bug. Owing to the danger of these rodents, despite the warfare that was made upon them, but little safety would have been afforded by the use of muslin bags supported on wire loops. Of all protective methods considered, glass globes have the advantage of offering practically no obstruction to light and view. Any kind of enclosure, however, will interfere with circulation of air and tend to increase temperature and humidity, and so far as muslin is used will furthermore reduce sunlight. All of the imposed influences produced by such causes must be taken into account as being at a variance with natural conditions.

Grain seedlings were grown in beds under field cages and transplanted in pots a day or two in advance of actual needs. By careful nursing during the hot weather a vigorous growth could be secured and depended upon for sustenance of the bugs in isolation. Oats sprouted in midsummer much better than wheat, and always survived more successfully after being set in pots.

The process of isolating the young bugs involved the greatest risk in dealing with them. They were transferred with best success by means of a dampened point of a fine camel's hair brush. Examples often had difficulty in attaching to the plant on which they were placed. Attempts to induce them to hang on a blade sometimes proved very vexatious. After some losses had occurred with individuals which failed in this manner, the placing of paper sheets on the earth surrounding the stem of the plant was found to be a wise plan. Then in case a young bug fell from a leaf it could readily be recovered and possibly replaced by patient attempts.

For shelter a special tent of strong canvas was erected on a framework of 2 by 4 in. lumber. The posts were set securely into the ground, being cross-braced to withstand heavy winds or severe storms. In accordance with the changes of weather,

the slack or shrinkage of canvas was easily kept at the proper tension by the adjustment of guy ropes on stakes in the usual way. Further strength and safety was secured by nailing a 12-inch ground board to the posts on all the sides and ends except across the space allowed for entrance, and the lower edges of the tent walls were tacked to this board. This construction also permitted an additional height of a foot for inside working room. In size the tent was 12 by 14 feet.

The ventilation of this tent was accomplished by the removal or only partial opening of the gables as desired, this feature being quite important. The gables, in fact, were independent sections that were held in place, when wanted, by means of buggy knobs fixed to the face of the rafters and cross-frame, and with eyes to match on the edges of the section of canvas itself. As the tent stood lengthwise in a north-and-south direction, with the entrance facing the north, the usual south winds had free range through the open gables and afforded a comfortable temperature inside during the hottest weather. The overhead air currents seldom interfered with the work of transferring young bugs, because the walls constituted an effective shield against the generally constant breeze. Strong and equally diffused sunlight was a distinct advantage that no other form of shelter having a darkened roof could possibly permit. Considering all the circumstances, this tent answered the purpose of an insectary quite satisfactorily, being especially suitable for temporary field work.

SYSTEM FOR ISOLATED BREEDING OF THE GREEN BUG.

Two breeding series, one being called the generation series and the other an individual series, were propagated for the purpose of acquiring detailed information upon the phases of development of *Toxoptera graminum*. In both series a system of designating the isolations of individuals was necessary to prevent confusion. My system as is outlined herewith, if not fully serviceable in so far as was employed for breeding the green bug, may perhaps be adapted for similar work with other aphids.

The main object in breeding generations was to carry on a lineal series with firstborn from first-matured individuals in order to determine the rate of successive occurrences in different months and in the whole length of time covered. Other particulars, such as developmental, maternal and total

life periods, daily and total reproduction, proportion of wingless and winged forms, and of sexes, were also noted to a certain extent without interfering with the regular succession of progeny.

In attempting to conduct breeding tests to the fullest extent and at the same time avoid too much complication in the process, the establishment of an individual series became necessary. As a matter of course, the stock for this series had to be drawn from the generation series, but it was not allowed to disarrange or risk in any way the direct line of descent nor to lose its relative connection, else the entire work would have been made worthless with regard to individual relations.

Generation Series. An explanation of the method of conducting the generation series is presented in the following outline:

For generation 1 establish series with a fertile female.

For generation 2 isolate each of the young from mother of series in consecutive order of daily birth, and number accordingly, 1, 2, 3, 4, 5, etc. Promptly designate each individual as "Gen. 2, No. —," for positive identification. Select No. 1 as mother for generation 3; in case No. 1 fails of reproduction, substitute No. 2; or if this fails, take No. 3; and so on by successive individuals if required further. Keep the life records according to actual dates, but in reckoning the continuity of generations on the basis of development from first-born individuals, deduct any loss of time, if more than a day, which the substitute should have in place of No. 1. With proper practice failures seldom occurred with more than two or three consecutive individuals of a generation, and very rarely amounted to as much as the loss of a day in difference of time.

For generation 4 and following ones, proceed in the same manner, designating each individual upon isolation by the proper "Gen. — and No. —."

Individual Series. The method pursued in conducting the individual series requires the following explanation:

This series should be begun with No. 2 of generation 2, provided it does not fail and is not needed as a substitute in the generation series; but No. 3, 4 and 5 of the same generation should be held in reserve against possible failures or accidents. All depends upon No. 1 having succeeded in pro-

pagating the generation series before No. 2, if alive and doing well, can be safely released from sharing responsibility in the continuation of the generation series. Otherwise, if the need of substitutes in place of No. 1 should require any of the successive individuals, or if No. 2 alone should fail, the starting of the individual series must be postponed until generation 3, or, if necessary, until a further one has advanced far enough to allow the serial separation of the desired individuals.

Continue this special breeding of serial offspring by selections from the generation series until each differently numbered individual has been treated for whatever purpose intended. In explanation, this statement does not mean, when in case No. 2 of generation 2 is used that No. 3 need be of the same generation, but rather of the following generation, and so on for all the numbers. However, should the matter of saving time be an object, provided that facilities for isolation are ample, two or three numbered individuals of a generation may be treated at one time with little risk of the results being at any material variance with results in case of similarly numbered individuals from different generations.

Whenever an individual has been carried as far as desired, or when the young are not wanted for this particular breeding, remove the superfluous bugs to a general stock cage or destroy. The stock cage is needed to furnish a supply of bugs for experiments with predators, and, when possible, with parasites; also for tests with different host plants, and for use in other ways including general observations.

PROBABLE INFLUENCE OF HOT WEATHER UPON THE GREEN BUG.

The experimental breeding of *Toxoptera gramium* during the summer months was somewhat disappointing in the outcome by not producing any change of form from the serial wingless viviparous females. In the stock cages, however, winged females appeared to constitute a moderate and fairly uniform proportion at all times in comparison with the predominant number of wingless females. The probable influence of hot weather culminated in no discernible effect except upon the fecundity of the bugs in the serial breeding.

Three or more factors, whose separate or combined influences might possibly have been exerted on the breeding of the

insects under observation, unavoidably entered into the experimental work, so that the reason for any change in the course of the lines of the insects could not be definitely attributed to the effect of one element alone, even such as temperature, without being proved by corroboration. One important factor which was apt to produce abnormal effects arose from the employment of artificial measures for breeding purposes. The responsibility of such circumstances demanded watchful consideration, and any unusual manifestation of the bugs needed to be conclusively understood and verified with regard to all features involved.

Therefore, as many questions remain open to dispute, no positive significance of results can be declared without substantiation by further experiments for one or more years. Hence progress in determining the reasons for effective results must necessarily be slow in order to be reliable.

The artificial condition under which the bugs were bred corresponded as nearly as possible with natural conditions, but still differed materially because confinement of the bugs was imperative. More constant and substantial provisions were required for studying these insects under close observation than could be offered them in nature. In consequence the bugs were afforded the best of advantages for their sustenance and propagation.

The most noticeable feature which was evinced during the summer in the existence of the bugs was a falling off in the number of young bugs born every day. From the standard daily production of eight young bugs by one adult the birth rate declined to three or four young ones per day, seldom being more, but often less, and rarely none at all. This reduction of one-half or more in the usual multiplication of the bugs could not be proved to have been caused by hot weather when other weighty reasons demand consideration, especially with regard to the effects of artificial conditions and continuous breeding from one generation to another without the intervention of males. However, this curtailment of the reproductive capacity was partly redeemed by a tendency of the bugs to attain an early maturity and begin bearing young ahead of the regular time. Such irregularity was shown in a number of instances, requiring only five or six days instead of the ordinary period covering eight days. Maturing in advance of the usual time hastened the appearance of consecutive generations.

Attempts to breed the bugs in the open sunshine eventually proved unsuccessful. These tests, however, demonstrated the hardiness of the bugs in withstanding a few days of exposure to sun heat, and then the failures were evidently induced by the wilting or scorching of the food-plants rather than to the direct effect of heat on the bugs. In one case, as long as the plant remained in a fresh condition an adult bore young, and all seemed to thrive for a few days in spite of being enclosed in a glass globe, which subjected both the plant and its tenants to a temperature several degrees higher than would have been the condition if the colonized plant were openly exposed to air. This test was made on a bare space of ground wholly unprotected from the sun during the hottest and dryest days in the last week of August, and it met disaster from the baking heat of the first day of September.

Another test giving proof that green bugs can stand more than 100° F. was demonstrated in the field or stock cages. These cages were constructed of wood frames, three feet square by 4 feet in height, covered with muslin cloth on all sides and top, and banked with earth around the bottom edges. Oats or wheat seedlings grown in these cages were colonized with green bugs, which multiplied rapidly at all times. Frequent watering of the soil in these cages was necessary to keep the plants in succulent growth, so that in addition to the temperature the interior was charged with a high humidity. Although the cloth covering subdued the glare of the sun, nevertheless the temperature inside probably ranged from 10° to 15° F. higher than on the outside.

The experimental results prove that *Toxoptera graminum,* when provided with suitable food plants and also protected from the baking heat of the sun, is able to live through the summer. This fact in itself indisputably refutes the popular impression that the species in any active form cannot withstand hot weather under any circumstances. The adverseness of natural conditions during midsummer principally accounts for the seasonal suppression of the insects, and these influences may rule for a number of years in keeping the pest under control.

Since no resting stage could be found when the bugs disappeared from the fields, the opinion gained common credence

that the pest had died out entirely. While this event might be possible in local instances, yet, in face of a logical consideration, the belief that extermination had become general was promptly discredited as being unreasonable as well as misleading. In the first place, if green bugs or any other kind of insect should wholly perish on account of one or more adverse seasonal conditions without having deposited eggs for reëstablishing its kind after the critical period had passed, such species would become extinct.

At harvest time, when the grain plants ceased to furnish nutriment for sustaining the pest, all the bugs apparently disappeared. But this incident did not make certain the prevailing notion that all had died. That the pest still existed in the country was evidenced by later developments, although these were not determined until the second season following. The species must therefore have survived the summer in some obscure manner and in such scarcity as to have escaped observation.

Even before the grain plants matured, the pest became scarce owing to the activity of its enemies instead of the effects of warmer weather, further than that the latter condition favored the enemies. Wingless forms seemed to perish outright with the drying of the plants, but the winged forms, being amply fitted for migration, doubtlessly flew away in search of some succulent plant on which they and their progeny could subsist. Just what shift these bugs make, lasting from harvest time until the fall planting of small grain has sprouted, could not be determined, as has been explained. Several kinds of grasses, however, are known to serve as alternative or possible summer food plants. The bugs evidently exist in some way, since they reappear in the fall or in successive seasons on the young grain plants in the fields.

On the whole, the experimental breeding of green bugs proved fairly successful throughout the hot and dry weather of July and August. The unfortunate part of my work at the end was occasioned by the abrupt termination of operations at the time when development of true sexual forms had barely become effective. Hence, this discontinuance resulted in the incompleteness of observations concerning oviparous females,

of which the first example matured late in November; but further, the closest attention failed of detecting any male examples.

Agricultural Experiment Station, Baton Rouge, La.

DETERMINATIONS AND RECORDS OF INSECTS COLLECTED AT PLANO, TEX.

By E. S. Tucker.

DURING the time extending from the first week in May to the end of December, 1907, which the writer spent in an investigation at study of the green bug (*Toxoptera graminum* Rond.) at Plano, Collin county, Texas, a fairly representative collection of insects was personally made in the locality. Although circumstances have since caused much unavoidable delay in the work of determining the species taken, yet the results of study of a considerable number of the specimens have been published from year to year. Some examples still remain unidentified, but as the names of most species obtained in the collection are now known, the further determinations and records can be presented herewith.

This paper is the sixth one treating of the collection, and the papers all together give a nearly complete report.[1]

In the present lists, the number of forms reported is 416, belonging in the different orders, as follows:

Diptera	184	Hemiptera	155
Siphonaptera	1	Thysanoptera	1
Hymenoptera	73	Corrodentia	1
		Chilopoda (Myriapoda)	1

Adding the 398 forms, as have been previously reported, to the number now cited makes a grand total of 814 species and varieties.

As many as sixteen new species and one new subspecies have been named from examples studied by myself or sub-

1. (*a*) Incidental Captures of Neuropterous Insects at Plano, Texas. (Psyche, v. 15, Oct., 1908, pp. 97-100.) Number of forms cited, 34.
(*b*) Incidental Captures of Lepidoptera at Plano, Tex. (Psyche, v. 16, June, 1909, pp. 58-64.) Number of forms cited, 130.
(*c*) Incidental Captures of Apterous and Orthopterous Insects at Plano, Tex. (Ent. News, v. 20, July, 1909, pp. 294-297.) [For "Plana," in heading, read "Plano."] Number of forms cited, 40.
(*d*) Incidental Captures of Cleoptera at Plano, Tex. Can. Ent., v. 42, July, 1910, pp. 229-237.) Number of forms cited, 178.
(*e*) Local Records of Arachnids Personally Collected in Kansas and Texas. (Trans. Kan. Acad. Sci., v. 23 24, 1911, p. 240 and 241.) Number of forms cited for Plano, Tex., 16.

mitted to the following authorities: Prof. O. A. Johannsen, one in the Mycetophilidæ; Dr. E. P. Felt, six in the Cecidomyiidæ; Mr. C. H. T. Townsend, one in the Tachinidæ; the author, two in the Oscinidæ, Prof. T. D. A. Cockerell, one in the Anthophoridæ; Mr. S. A. Rohwer, one in the Trypoxylidæ; Dr. B. Poppius, one in the Capsidæ; Mr. E. P. Van Duzee, one in the Fulgoridæ; Prof. H. Osborn, two in the Jassidæ, and Mr. D. L. Crawford, one in the Psyllidæ. References are given to the descriptions so far as they have been published.

To Dr. L. O. Howard, chief of the Bureau of Entomology, and to Dr. W. D. Hunter, in charge of Southern Field Crop Insect Investigations, United States Department of Agriculture, my thanks are due for their kindness in affording me numerous accommodations. Through the courtesy of Dr. Howard, the services of experts under his direction have been promptly granted. Where credit for determinations is not individually stated in my list, the specific citations are given on my own responsibility. Most of these species were identified through comparison with authentically named examples in the collection of the United States entomological laboratory at Dallas, Tex., and the remaining specimens were studied in the United States National Museum, Washington, D. C.

Order DIPTERA.

Arrangement follows Aldrich's catalogue, except where otherwise stated.

SUMMARY OF FAMILIES AND SPECIES, INCLUDING VARIETIES.

Tipulidæ	6	Tachinidæ	23
Chironomidæ	22	Dexiidæ	2
Culicidæ	10	Sarcophagidæ	5
Mycetophilidæ	3	Muscidæ	3
Cecidomyiidæ	8	Anthomyidæ	8
Bibionidæ	2	Helomyzidæ	1
Stratiomyidæ	3	Sciomyzidæ	2
Tabanidæ	3	Sapromyzidæ	2
Bombyliidæ	3	Ortalidæ	2
Scenopinidæ	2	Trypetidæ	5
Mydaidæ	1	Sepsidæ	1
Asilidæ	6	Ephydridæ	3
Dolichopodidæ	8	Oscinidæ	19
Empididæ	2	Drosophilidæ	3
Pipunculidæ	1	Geomyzidæ	1
Syrphidæ	12	Agromyzidæ	7

Families represented, 32; total number of forms, 184.

Family TIPULIDÆ.

Geranomyia canadensis Westw. October.
Goniomyia cinerea Doane. August, at night, taken at trap light.
Goniomyia sulphurella O. S. May.
Helobia hybrida Meig. October, in window of house.
Pachyrhina ferruginea Fab. May.
Tipula bella Lw. May. (Det. by R. W. Doane.)

Family CHIRONOMIDÆ.

The generic names in this family are arranged according to the rank given them by Prof. O. A. Johannsen.[2] All determinations not accredited to Professor Johannsen were made by D. W. Coquillett.

Ceratopogon bimaculatus Lw. July.
longipennis Lw. July, at night, taken at trap light.
squamipes Coq. May, September, at night, taken at trap light; November at random, and in field cage with oats seedlings.
varriipennis Coq. July, at night, taken at trap light. § Sp., undescribed, fide Johannsen. June. Professor Johannsen stated that, "Without more material I should not care to undertake describing it."
Procladius nubifer Coq.[3] July to September, at night, taken at trap light; October, at night, by sweeping; and November.
Tanypus bellus Lw. August, at night, taken at trap light.
culiciformis L.[4] September, at night, taken at trap light.
monilis L. July and September, at night, taken at trap light.
pallens Coq. September, twilight, all males; and September at night, taken at trap light, both sexes.
scapularis Lw. September, at night, taken at trap light.
stellatus Coq. August and September, at night, taken at trap light.
tricolor Lw. August, at night, taken at trap light.
Chironomus cristatus Fab. July to September, at night, taken at trap light.
decorus Joh.[5] May, August and September, all at night, taken at trap light; October, at night, by sweeping; and November. (Det. by O. A. Johannsen.)
modestus Say. August, at night, taken at trap light. (Det. by O. A. Johannsen.)
redeuns Wk. July to September, at night, taken at trap light. (Det. by O. A. Johannsen.)
tænionotus Say. July to September, at night, taken at trap light.
sp. August, at night, taken at trap light; October, at night, by sweeping. (Defective specimen, Det. by O. A. Johannsen.)
Orthocladius nivoriundus Fitch. May, at dusk, in oats field. Also taken in Dallas, Tex., February 24, 1908. (Det. by O. A. Johannsen.)

2. New York State Museum Bulletin No. 86.
3. See Johannsen, N. Y. St. Mus. Bul. 124, p. 270.
4. See Johannsen, N. Y. St. Mus. Bul. 86, p. 158.
5. See Johannsen, N. Y. St. Mus. Bul. 86, p. 239.

politus Coq. May; May, in oats field, clinging on under side of oat blade.

Metriocnemus atratulus Zett. Taken at Dallas, Tex., February 8, 1908, at twilight in window of house. (Det. by O. A. Johannsen.) The species can safely be recorded for Plano, which is only 17 miles north of Dallas.

Family CULICIDÆ.

Determinations were made by H. G. Dyar, excepting the last species.

Anopheles pseudopunctipennis Theob. September.

punctipennis Say. May and August, all at night, taken at trap light.

quadrimaculatus Say. September.

Culex abominator D. &. K. One male, September, at night, taken at trap light.

restuans Theob. May, at dusk, in oats field; November, twilight, male.

tarsalis Coq. September; September, at night, taken at trap light.

Ædes nigromaculis Lud. May, at dusk, males swarming; August, at night, taken at trap light, and November.

sayi D. &. K. October.

sylvestris Theob. May, at dusk, in oats field.

Sayomyia punctipennis Say. August and September, at night, taken at trap light; and October. (Det. by D. W. Coquillett.)

Family MYCETOPHILIDÆ.

Platyura elegans Coq. August; September, at night, taken at trap light. Det. by D. W. Coquillett.)

Sciara coprophila Lint. May, June, November. (Det. by O. A. Johannsen.)

varians Joh.[6] May, at dusk, in oats field; June, November. Also taken at Dallas, Tex., March 3, 1908, in house at night. (Det. by O. A. Johannsen.)

Family CECIDOMYIIDÆ.

Arrangement of genera accords with the classification proposed by E. P. Felt,[7] to whom are accredited all the determinations.

Microcerata spinosa Felt. May, at dusk, in oats field. (Type.)

texana Felt.[8] July. (Type.)

Lestremia sp. May, at dusk, in oats fields; July, in cornfield. Dr. Felt remarked that specimens were "too poor to characterize."

Campylomyza texana Felt.[9] November, occurring in field cage with seedling oats on which green bugs (*Toxoptera graminum* Rond.) were being reared. (Type.)

Prionellus monilis Felt.[10] November, in field cage, same as for preceding species. (Type.)

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6. Me. Agr. Exp. Sta., Bul. 200, p. 135.
7. N. Y. St. Mus. Bul. 165, pp. 145 and 146.
8. N. Y. St. Mus. Bul. 165, pp. 147 and 148.
9. N. Y. St. Mus. Bul. 124, p. 316, and Bul. 165, pp. 170 and 171.
10. N. Y. St. Mus. Bul. 165, p. 175.

Monardia (*Campylomyza*) *tuckeri* Felt.[11] November. (Type.)
Neolasioptera sp. August, (Dr. Felt considered it "too poor to describe.")
Coquillettomyia texana Felt.[12]. September, appearing in field cage with seedling oats stocked with green bugs (*Toxoptera graminum* Rond.). Dr. Felt remarked that, "This form is probably zoöphagous, and may have been breeding upon the aphids." (Type.)

Family Bibionidæ.

Dilophus serraticollis Wk. December. (Det. W. A. Hooker.)
Scatopse pulicaria Lw. May, at dusk, in oats field. (A teneral specimen, det. by O. A. Johannsen.)

Family Stratiomyidæ.

Hermetia illucens L. July; August; August, in house; September; September, in house; October and November. Occurred commonly about privy, where it evidently bred in excrement.
sexmaculata Macq. October and November. Associated with *H. illucens* L.
Stratiomyia constans Lw. July.

Family Tabanidæ.

Tabanus atratus Fab. June, attempting to bite horse; July, a male was taken while apparently feeding on honey-dew produced by a colony of *Aphis maidis* Fitch on corn plant; and August.
sulcifrons Macq. August, occurring most numerously in this month, but only one male was taken; September and October. Generally annoying horses and cattle.
venustus O. S. June, one male.

Family Bombyliidæ.

Spogostylum fur O. S. September.
œdipus Fab. September.
Anthrax lucifer Fab. October and October, twilight.

Family Scenopinidæ.

Scenopinus glabrifrons Meig. October.
nubilipes Say. June.

Family Mydaidæ.

Mydas clavatus Dr. June.

Family Asilidæ.

Leptogaster murinus Lw. May.
Stenopogon longulus Lw. August, one of the specimens was grasping a lanced-tailed meadow-hopper (*Xiphidium strictum* Sc.) when captured. (Det. by J. S. Hine.)
Atomosia glabrata Say. June, July and August.
puella Wd. June and July.
Erax æstuans L. June, July and August.
sp. July. A male specimen.

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11. N. Y. St. Mus. Bul. 124, p. 316, and Bul. 165, pp. 190 and 191.
12. N. Y. St. Mus. Bul. 124, pp. 382 and 398.

Family Dolichopodidæ.

Psilopodinus inornatus Ald. July. (Det. by D. W. Coquillett.)
sipho Say. July, in oats field; August.
Diaphorus leucostoma Lw. July.
Nothosympycnus nodatus Lw. October; October, at night, by sweeping; November, in field cage with oats seedlings. All female specimens, which are difficult to determine, but they agreed with authentic examples.
Dolichopus bifractus Lw. October, twilight.
Paraclius (*Pelastoneurus*) *alternans* Lw. September, at night, taken at trap light. (Det. by D. W. Coquillett.)
pumilio Lw. July. Det. by J. M. Aldrich, who remarked: "It is rare in collections, and I have not seen the male.")
Pelastoneurus vagans Lw. May, at dusk, in oats field.

Family Empididæ.

Drapetis latipennis Mel. May.
Hemerodromia empiformis Say. July. (Det. by D. W. Coquillett.)

Family Pipunculidæ.

Pipunculus subvirescens Lw. July in corn field.

Family Syrphidæ.

Microdon (*Omegasyrphus*) *baliopertus* Lw. October.
Chrysogaster nitida Wd. July.
Baccha clavata Fab. July and September.
Platychirus quadratus Say. October.
Syrphus americanus Wd. October, December.
Allograpta obliqua Say. July.
Mesogramma marginata Say. July; July in oats field, wheat stubble and alfalfa, August; and October.
polita Say. July; July in oats field; August; and September.
Sphærophoria cylindrica Say. October.
Eristalis latifrons Lw. September.
transversus Wd. October.
Syritta pipiens L. September.

Family Tachinidæ.

Cistogaster immaculata Macq. July; October; and October, twilight.
Phorantha occidentis Wk. July, in oats stubble.
Paradmontia brevis Coq. October. (Det. by D. W. Coquillett.)
Phasmophaga meridionalis Town.[13] July, in oats stubble field. (Type.)
Leucostoma atra Town. October twilight. (Det. verified by D. W. Coquillett.)
neomexicana Town. October, twilight. (Det. by C. H. T. Townsend.)
Œstrophasia ochracea Bigot. September; September, at night, taken at trap light. (Det. by C. H. T. Townsend.)
Beskia ælops Wk. July, in corn and wheat-stubble fields, and at random.

13. An. Ent. Soc. Amer., v. 2, Dec., 1909, p. 244.

Epigrymyia floridensis Town. October, at night, by sweeping. (Det. verified by D. W. Coquillett.)

Exorista boarmiæ Coq. October and November. (Det. by D. W. Coquillett.)

Euphorocera claripennis Macq. August; November. (Det. verified by D. W. Coquillett.)

Phorocera doryphoræ Riley. June; July, in oats-stubble field; August. (Det. verified by D. W. Coquillett.)

tortricis Coq. July, in cornfield. (Det. verified by D. W. Coquillett.)

Sturmia distincta Wd. August, in cornfield.

inquinata V. d. W. August, in house. (Det. verified by D. W. Coquillett.)

Sturma (Masicera) normula V. d. W. October and November. (Det. by D. W. Coquillett.)

pilatei Coq. July. (Det. by D. W. Coquillett.)

Tachina rustica Fal. November.

Winthemia quadripustulata Fab. October. (Det. by D. W. Coquillett.)

Chætogædia monticola Bigot. November, an undersized example. (Det. verified by D. W. Coquillett.)

Microphthalma disjuncta Wd. July; September, at night, taken at trap light.

Trichophora ruficauda V. d. W. July and August.

Archytas analis Fab. July.

Family Dexiidæ.

Dexia (Myiocera) pexaspes Wk. October and November. (Det. by D. W. Coquillett.)

Ptilodexia (Myiocera) tibialis Desv. October.

Family Sarcophagidæ.

Sarcophaga assidua Wk. September, at night, taken at trap light. August, October, and November.

sarraceniæ Riley. May, at dusk, in oats field, July, in kitchen, evidently attracted by odor from cooking of fresh meat.

varicauda Coq. (Not cited in Aldrich's catalogue.) July, in cornfield.

Helicobia helicis Town. May, at dusk, in oats field; August; October; and October, twilight.

quadrisetosa Coq. May, at dusk, in oats field, July, in alfalfa and cornfield, and at random, August, on cow dung, and at night, taken at trap light and at random; October; October twilight; and November.

Family Muscidæ.

Chrysomyia macellaria Fab. During the summer screw worms were reported as a common pest of livestock. On August 16, a farmer was found engaged in applying treatment to kill the maggots in sores on a heifer and a calf, and also in a torn ear of a pig. Larvæ were removed from lacerations on the foot of a boy, September 4. Adults collected in November.

Cynomyia cadaverina Desv. November; December, in window of house.
Calliphora erythrocephala Meig. October.
Lucilia sericata Meig. August, in house; September. A specimen taken in May by sweeping at dusk in oats field was determined by C. H. T. Townsend as a form which he had described by the name *barberi*, but it has since been considered as merely the male of *sericata*, having first segment of abdomen darkened.
Phormia regina Meig. November; December, in window of house.
Pseudopyrellia cornicina Fab. May; June; June, in cornfield; October, and November.
Musca domestica L. Common during the season.
Stomoxys calcitrans L. May to October, occasionally inflicting bites during midsummer.

Family ANTHOMYIDÆ.

Limnophora disereta Stein. October, twilight.
narona Wk. October.
Anthomyia albicincta Fal. May.
Phorbia cinerella Fal. June.
fusciceps Zett. May; May, at dusk, in oats field; June, in cage in oats field, October; October, in oats field; October, twilight, November; November, in field cage with oats seedlings, and December, in window of house.
Cœnosia flavicoxa Stein. July.
lata Wk. May, at dusk, in oats field.
Schœnomyza dorsalis Lw. November.

Family HELOMYZIDÆ.

Leria pectinata Lw. November, in field cage with oats seedlings.

Family SCIOMYZIDÆ.

Sciomyza humilis Lw. October.
Tetanocera umbrarum L. October, at night, by sweeping.

Family SAPROMYZIDÆ.

Pachycerina clavipennis Coq. May; May, at dusk, in oats field; June, at large and in cages in oats field; July; July, in cornfield, October; October, in oats field; November; and November, in oats field.
Sapromyza sordida Wd. May, at dusk, in oats field.

Family ORTALIDÆ.

Chætopsis ænea Wd. May, at dusk, in oats field; August. (Det. by E. T. Cresson, Jr.)
Eumetopia rufipes Macq. July, in cornfield. (Det. by E. T. Cresson, Jr.)

Family TRYPETIDÆ.

Eutreta sparsa Wd. May, at dusk, in oats field.
Carphotricha culta Wd. May. (Det. by E. T. Cresson, Jr.)
Ensina humilis Lw. November.
Euaresta æqualis Lw. August; September, at night, taken at trap light. (Det. by E. T. Cresson, Jr.)
Urellia abstersa Lw. August. (Det. by E. T. Cresson, Jr.)

Family Sepsidæ.

Sepsis violacea Meig. June, in oats field, at large and in cages.

Family Ephydridæ.

Notiphila scalaris Lw. September, at night, taken at trap light. (Det. by E. T. Cresson, Jr.)

Paralimna appendiculata Lw. July; July, at night, taken at trap light.

Psilopaa trimanus Lw. August.

Family Oscinidæ.

Meromyza americana Fitch. May, at dusk, in oats field; July, in oats field; and October, in oats field.

Chlorops assimilis Macq. May, at dusk, in oats field; June, in house; July, in cornfield; and October.

nigricans Lw. September; September, at night, taken at trap light; October, at night, by sweeping.

rufescens Coq.[14] May, at dusk, in oats field. One specimen. (Det. by D. W. Coquillett.)

unicolor Lw. May, at dusk, in oats field; June; July, in corn field.

Ectecephala albistylum Macq. May, at dusk, in oats field.

Ceratobarys eulophus Lw. June, in cage in oats field; July.

Hippelates plebeius Lw. June, causing annoyance by attempting to alight on face and eyes; July; and July, twilight, annoying on hands and face; and August.

pusio Lw. June, causing annoyance by attepmting to alight on face and eyes; July; and July, twilight, annoying on hands and face; July, in cage, in oats field; September, October; November; and November, in oats field.

stramineus Lw. July, in cornfield.

Elachiptera costata Lw. June, in cage in oats field; July, in cornfield.

nigriceps Lw. June, in cage in oats field.

nigricornis Lw. June, in cage in oats field.

Siphonella cinerea Lw. June.

Oscinis carbonaria Lw. May, at dusk, in oats field; July, in cornfield.

coxendix Fitch. June.

dissidens Tkr.[15] June. (Type.)

frontalis Trk.[16] May, at dusk, in oats field, one female specimen; and November, one male specimen. (Types.)

variabilis Lw. May; June; July; July, in cornfield; August; October; and November. This species was the most common oscinid collected.

Family Drosophilidæ.

Drosophila funebris Fab. November. One specimen.

sigmoides Lw. (Not cited in Aldrich's catalogue.) May, at dusk, in oats field.

Scaptomyza adusta Lw. October.

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14. Can. Ent., v. 42, Feb., 1910, p. 45.
15. Ent. News, v. 19, June, 1908, p. 274.
16. Ent. News, v. 19, June, 1908, p. 273.

Family GEOMYZIDÆ.

Anthomyza nigrimanus Coq. June, in cage, in oats field.

Family AGROMYZIDÆ.

Agromyza æneiventris Fal. July.

parvicornis Lw. July, in alfalfa field.

platyptera Thom. (=*jucunda* V. d. W.) May; August.

pusilla Meig. (= ? *diminuta* Wk.); July, in cage in oats field. Also bred from cotton leaves, July, 1910.

simplex Lw. October, twilight.

viridula Coq. June, July.[17]

Milichiella (*Ophthalmomyia*) *lacteipennis* Lw. July, in oats-stubble field; September, and transported on squash bug; October in oats field.

Order SIPHONAPTERA.

Family PULICIDÆ.

Pulex irritans L. June to September, a troublesome pest in house.

Order HYMENOPTERA.

The work of specific determinations in the order Hymenoptera is not quite finished, but no promise can be made at this time for its fulfillment. Although Ashmead's classification has been greatly modified, and the latest arrangement of lists of Hymenoptera practically reverses the old method, yet the former system will serve in a general way for present purposes.

SUMMARY OF FAMILIES AND SPECIES, INCLUDING VARIETIES.

Apidæ	1	Sphecidæ	3
Bombidæ	2	Vespidæ	4
Xylocopidæ	1	Eumenidæ	3
Anthophoridæ	7	Poneridæ	1
Nomadidæ	2	Dorylidæ	3
Megachilidæ	5	Myrmicidæ	5
Stelidæ	1	Dolichoderidæ	1
Colletidæ	2	Camponotidæ	1
Andrenidæ	7	Chalcididæ	4
Psenidæ	2	Eurytomidæ	1
Bembecidæ	1	Pteromalidæ	1
Larridæ	3	Mymaridæ	1
Philanthidæ	3	Ichneumonidæ	3
Trypoxylidæ	3	Braconidæ	2

Families represented, 28; total number of forms, 73.

17. See J. R. Malloch, An. Ent. Soc. Amer., v. 6, No. 3, Sept., 1913, p. 313.

Family APIDÆ.

Apis mellifera L. Frequently observed during the summer, several miles from hives.

Family BOMBIDÆ.

Bombus americanum Fab. July, in oats field, female; August, worker; and October, a male.

pennsylvanicus De G. October.

Family XYLOCPIDÆ.

Xylocopa virginica Dru. May, hovering at board fence.

Family ANTHOPHORIDÆ.

Florilegus condigna Cr. August, a male. (Det. by T. D. A. Cockerell, who remarked: "A typical humid-region insect.")

Melissodes agilis semiagilis Ckll. October.

atripes Cr. July.

aurigenia Cr. July. (Prof. T. D. A. Cockerell considers this as a variety of *M. agilis* Cr.)

hitei Ckll. August, a female. (Det. by T. D. A. Cockerell, who wrote about it as follows: "Described as *M. martini hitei* from a single example taken at Pueblo, Colo., and this is the second known. As the characters exactly agree, and the insect is now shown to have a wide range, I doubt not that it is a good species. There are others much like it in Texas, but they have some black hairs on the thorax above, and differ otherwise. I wish you could find out something about the habits of this species, and if possible discover the male.")

obliqua Say. August.

tuckeri Ckll.[18] October, two females. (Type and paratype.)

Family NOMADIDÆ.

Epeolus bifasciatus Cr. July and August. (Det. by T. D. A. Cockerell.)

occidentalis Cr. October.

Nomada texana Cr. July and August. (Det. by T. D. A. Cockerell.)

Family MEGACHILIDÆ.

Osmia subfasciata Cr. June. (Det. by T. D. A. Cockerell, who added the following remark: "This does not agree well with Cresson's description, but it appears to be identical with one of Cresson's types, which I examined in Mus. Comp. Zoölogy.")

Megachile brevis Say. July, a female specimen. (Det. by T. D. A. Cockerell.)

kallstrœmiæ Ckll. October, a female specimen. (Det. by T. D. A. Cockerell, who remarked as follows: "*M. kallstrœmiæ* and *vallorum* are characteristic arid-region bees. According to V. Bailey's map, Plano is in the humid part of Texas. Some interesting work might be done on the transition from the arid to the humid belts, as shown by the bees.")

sexdentata Robt. August. (Det. by T. D. A. Cockerell, who offered the following remarks: "This is close to *M. prunina* Sm. and has

18. Can. Ent., v. 41, April, 1909, p. 129.

no doubt been confused with it. I am almost sure that *sexdentata* is a synonym of *M. facunda* Cr., *M. prunina* Sm. (*parallela* Sm.) being closely allied but distinct.")

vallorum Ckll. June and August. (Det. by T. D. A. Cockerell, whose remark concerning it is already quoted for the species *kallstrœmiæ*.)

Family Stelidæ.

Cœlioxys texana Cr. June.

Family Colletidæ.

Colletes crawfordi Schwenk. July, one female specimen. Compared with metatype, and also found to agree with description in all particulars except that no black hairs appeared on any part of body; hence it may be called a pale form. Collected within 17 miles of type locality, and its earlier seasonable occurrence may be responsible for the possible male-like vestiture.

latitarsis Robt. July.

Family Andrenidæ.

Augochlora confusa Robt. July and August.

fervida Sm. August; September; October, twilight.

(Oxystoglossa) similis Robt. July, a single male example.

Agapostemon texanus Cr. July.

Halictus connexus Cr. July. (Det. by J. C. Crawford.)

disparilis Cr. June; July, in wheat-stubble fields; August. (Det. by J. C. Crawford.)

ligatus Say. July; October; November.

Family Psenidæ.

Neofoxia suffusus Fox. July; July, in cage in oats field, and in wheat-stubble field; August. (Det. by S. A. Rohwer.)

tibialis Cr. July, in oats-stubble field. (Det. by S. A. Rohwer.)

Family Bembecidæ.

Bembex nubilipennis Cr. July and August.

Family Larridæ.

Tachytes distinctus Sm. August.

sericatus Cr. July; July, in oats field.

Astatus bicolor Say. July, in cage in oats field; October. (Det. by S. A. Rohwer.)

Family Philanthidæ.

Cerceris insolita Cr. October. (Det. by S. A. Rohwer.)

kennicottii Cr. October. (Det. by S. A. Rohwer.)

mimica Cr. August. (Det. by S. A. Rohwer.)

Family Trypoxylidæ.

Trypoxylon albopilosum planoense Roh.[19] June. (Type.)

carinifrons Fox. August, September.

texense Sauss. June.

19. Ent. News, v. 20, Nov., 1909, p. 380.

Family Sphecidæ.

Isodontia harrisi Fern., (=*philadelphica* Lep.) September.
Chalybion cæruleum L. August; September, in house.
Sceliphron (Pelopœus) cementarius Dru. June; June and July, in house; August; and September, in house.

Family Vespidæ.

Polistes annularis L. August; October; and November.
minor Beauv. August, male and female, September; October, November; and November, for variety of female.
rubiginosus Lep. June, incage in oats field; and July to December, taken in house during the last three months.
texanus Cr. August; October; November.

Family Eumenidæ.

Odynerus hidalgi Sauss. Mexican var. of female. August.
Ancistrocerus fulvipes Sauss. July to September.
Monobia quadridens L. June.

Family Poneridæ.

Ponera trigona opacior Forel. June, in cages in oats fields and at random; July, at night, taken at trap light and in cages in oats fields; October, in flight. Females.

Family Dorylidæ.

Eciton (Acamatus) harrisi Hald. August, at night, taken at trap light, a male specimen.
(Acamatus) melsheimeri Hald. July and August, at night, taken at trap light, all males.
(Acamatus) minor Cr. August, at night, taken at trap light, a male specimen.

Family Myrmicidæ.

Myrmecina graminicola, americana Emery. July, at night, taken at trap light, a male specimen.
Monomorium minimum Buckley. June, troublesome on pantry shelves and in other parts of house; also destructive to insect specimens, workers and males.
Solenopsis geminata diabola Wheeler. June, nesting in hard, bare ground; June to September, troublesome in house, especially food supplies; and September in fields. Workers and males. In October these ants were observed attacking termites (*Termes lucifugus* Rossi.) as they emerged from a sod nest.
Cremastogaster lincolata læviuscula var. *clara* Mayr. June and July, females.
Strumigenys sp. A male, which may possibly be *louisiana* Roger. June.

Family Dolichoderidæ.

Forelius maccooki Forel. July, a female.

Family Camponotidæ.

Brachymyrmex sp. July at night taken at trap light, male.

Family CHALCIDIDÆ.

Leucopis affinis Say. November.
Chalcis ovata Say. November.
Podagrion mantis Ashm. June, in cage in oats field.
Eniacaca texana Ashm. June, in cage in oats field.

Family EURYTOMIDÆ.

Eurytoma tylodermatis Ashm. July, in oats field; August, by sweeping.

Family PTEROMALIDÆ.

Neocatolaccus tylodermæ Ashm. July and August, by sweeping.

Family MYMARIDÆ.

Polynema œcanthi Ashm. June, in cage in oats field.

Family ICHNEUMONIDÆ.

Compsocryptus calipterus Say. October.
Ophion bilineatus Say. October; October, at night, taken at trap light. (Det. by C. W. Hooker.)
Enicospilus purgatus Say. October. (Det. by C. W. Hooker.)

Family BRACONIDÆ.

Glyptomorpha rugator Say. August.
Microbracon (*Bracon*) *mellitor* Say. July and August, by sweeping.

Order HEMIPTERA.

Practically the same arrangement of the Hemiptera as has been used in my former lists is followed at this time, although a new subordinal division is recognized by the name Phytophthires.

SUBORDER HETEROPTERA.

SUMMARY OF FAMILIES AND SPECIES, INCLUDING VARIETIES.

Cydnidæ	6	Reduviidæ	10
Pentatomidæ	13	Anthocoridæ	1
Coreidæ	11	Capsidæ	19
Berytidæ	1	Emesidæ	2
Lygæidæ	16	Gelastocoridæ	1
Tingidæ	2	Corisidæ	2
Aradidæ	1		

Families represented, 13; total number of forms, 85.

Family CYDNIDÆ.

Thyreocoris gillettei Van. D. July in oats-stubble field.
unicolor Beauv. June and July.
Cyrtomenus mirabilis obtusus Uhl. July and October, at night, taken at trap light. (Det. by O. Heidemann.)
Pangæus spangbergi Sign. July and August, at night, taken at trap light.
Amnestus pusillus Uhl. July, at night, taken at trap light.

Schirus cinctus Beauv. June; July at random and at night taken at trap light.

Family Pentatomidæ.

Podops sp., near *parvulus* Van D. July, in cage in oats field. A single male specimen. (Det. by O. Heidemann as probably n. sp., female wanted.)

Brochymena cariosa Stal. November.

quadripustulata Fab. November and December.

Peribalus limbolarius Stal. August, at night, taken at trap light.

Mormidea lugens Fab. July, in cage in oats field.

Œbalus pugnax Fab. June and July, in cages in oats field and in field at large; July and August at random and at night taken at trap light.

Eusehistus impictiventris Stal. August, at night, taken at trap light.

servus Say. July in cage in oats field and in field at large and otherwise at random; October.

Thyanta casta Stal. November; December, twilight.

custator Fab. July, in oats field, July to September, at night, taken at trap light.

Nezara hilaris Say. October, in cotton field, and at night taken at trap light; November.

Mecidea longula Stal. July and August, at night, taken at trap light; August, at random.

Podisus maculiventris Say. September, at night, taken at trap light; October, at random, one specimen found with its beak inserted forwards into a caterpillar of *Euchlea chloris* H.-S.

Family Coreidæ.

Acanthocephala declivis Say. August and October.

femorata Fab. October.

Euthochtha galeator Fab. July.

Leptoglossus phyllopus L. July; July in oats field; August; October; and November.

Chariesterus antennator Fab. July, in oats and wheat-stubble fields and otherwise at random.

Anasa tristis DeG. May, September, October, and December. Found in hibernation during the last month.

Jadera hæmatoloma H-S. November.

Harmostes propinquus Dist. November.

reflexulus Stal. October, at night, sweeping.

Corizus hyalinus Fab. July, in wheat-stubble field; August.

lateralis Say. November.

Family Berytidæ.

Jalysus spinosus Say. May, November, and November in oats field.

Family Lygæidæ.

Oncopeltus fasciatus Dall. October.

Nysius angustatus Uhl. July, at night, taken at trap light.

californicus Stal. May, at dusk, in oats field; July and August, at night, taken at trap light.

Blissus leucopterus Say. May, immature stages, in oats fields; June, in cages in oats fields; July, in cages and at large in oats fields and otherwise at random; August; October, in cornfield; November, and December.

Geocoris bullatus Say. July, in alfalfa field.

Phlegyas annulicrus Stal. May, at dusk, in oats field.

Myodocha serripes Oliv. May, at dusk, in oats field; July; November.

Heræus plebejus Stal. July, at night, taken at trap light. (Det. by O. Heidemann.)

Pamera bilobata Say. July, in oats-stubble field, and at night, taken at a trap light. (Det. by O. Heidemann.)

Ptochiomera nodosa Say. July, at night, taken at trap light.

Peritrechus fraternus Uhl. August, at night, taken at trap light. (Det. by O. Heidemann.)

tristis Van D. August, at night, taken at trap light. (Det. by O. Heidemann.)

Ligyrocoris nitidula Uhl. September, at night, taken at trap light. (Det. by O. Heidemann as "dwarf specimen.")

Phorticus collaris Stal. August, at night, taken at trap light. (Det. by O. Heidemann.)

Paromius Longulus Dall. May; May, at dusk, in oats field; June, in cage in oats field; July, in cage in oats field and in wheat-stubble field. Taken in larval, nymphal and adult stages. Also July and September, at night, taken at trap light; and December.

Perigenes fallax Heid. July and August at night taken at trap light.

Family TINGIDÆ.

Piesma cinerea Say. November, in field cage.

Corythuca juglandis Fitch. July and August.

Family ARADIDÆ.

Aradus similis Say. October; October, at night, by sweeping. (Det. by O. Heidemann.)

Family REDUVIIDÆ.

Stenopoda culiciformis Fab. August, at night, taken at trap light.

Melanolestes abdominalis H-S. July to October, at night, taken at trap light; October, one specimen at random.

Zelus exanguis Stal. November.

renardi Kol. October, in cotton field, and at random.

Sinea diadema Fab. October; October, twilight, and at night by sweeping; November.

spinipes Stal. July, in oats field; August.

Pnirontis infirma Stal. September, at night, taken at trap light. (Det. by O. Heidemann.)

Oncocephalus geniculatus Stal. August, at night, taken at trap light.

Nabis capsiformis Germ. July, at night, taken at trap light.

ferus L. July, in wheat-stubble field; August, at night, taken at trap light.

Family ANTHOCORIDÆ.

Triphleps insidiosus Say. June in cage in oats field, July in oats field, October, December.

Family CAPSIDÆ.

Reuteroscopus (Episcopus) ornatus Reut. July; July, at night, taken at trap light.

Pseudatomoscelis tuckeri n. sp. Poppius.[20] Nearly resembles *Reuteroscopus unidus* Dist. October, at night, taken at trap light.

Atomoscelis sericatus Reut. July; July, at night, taken at trap light.

Strongylotes saliens Reut. May. (Det. by O. Heidemann.)

Chlamydatus (*Agalliastes*) *associatus* Uhl. July, in oats field and otherwise at random; August; and August, at night, taken at trap light.

Orthotylus sq., near *flavosparsus* Sahl. September, at night, taken at trap light. (Specimen examined by O. M. Reuter, who reported: "The species is unknown to me.")

Ceratocapsus (*Melinna*) *elongata* Uhl. September, at night, taken at trap light; October, at random; and November, at night, taken at trap light. (Det. verified by O. Heidemann.)

Lygus pratensis L. August; August, at night, taken at trap light; and October.

sallei Stal. August; August, at night, taken at trap light; September; September, at night, taken at trap light; October, twilight and at night, by sweeping; November, twilight.

Pœciloscytus basalis Reut. July to September, at night, taken at trap light; September, at random; October, twilight.

Calocoris rapidus Say. July and August; also July to September, at night, taken at trap light.

Phytocoris breviusculus Reut. July; July and August, at night, taken at trap light. (Det. by O. Heidemann.)

canescens? Reut. October; October, twilight. (Det. by O. Heidemann as "immature.")

Resthenia insignis Say. July, September, at night, taken at trap light.

Trigonotylus brevipes Jak. August. (Det. by B. Poppius.)

pulcher Reut. July at night taken at trap light, August. (Det. by B. Poppius.)

Rhinacloa forticornis Reut. May. (Det. by O. Heidemann.)

Megacœlum catulum Uhl. September. (Det. by O. Heidemann.)

Semium hirtum Reut. November. (Det. by O. Heidemann.)

Family EMESIDÆ.

Emesa longipes De G. October.

Hydrometra martini Kirk. August, at night, taken at trap light. (Det. by O. Heidemann.)

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20. Description announced for An. Soc. Ent. Belg.

Family GELASTOCORIDÆ.

Gelastocoris sp., usually called *oculata* Fab. June, on muddy bank of small stream. (Det. by J. R. de la Torre Bueno, who stated: "May describe the species sometime.")

Family CORISIDÆ.

Corisa burmeisterii Fieb. July to October, at night, taken at trap light; and August, in small stream. (Det. by O. Heidemann.)

scutellata Riley?[21] July, at night, taken at trap light; male and female.

SUBORDER HOMOPTERA.

SUMMARY OF FAMILIES AND SPECIES, INCLUDING VARIETIES.

Cicadidæ	1	Cercopidæ	2
Membracidæ	4	Jassidæ	37
Fulgoridæ	12		

Families represented, 5; total number of forms, 56.

Family CICADIDÆ.

Cicada superba Fitch. August.

Family MEMBRACIDÆ.

Entylia sinuata bactriana Ger. July, August, and October. (Det. verified by H. Osborn.)

Stictocephala festina Say. July, in oats, and wheat-stubble fields, but more commonly taken in alfalfa fields and otherwise at random; August. (Det. verified by H. Osborn.)

Acutalis calva Say. July, in cornfield.

tartrea semicrema Say. July.

Family FULGORIDÆ.

Amphiscepa bivittata Say. August.

Scolops sulcipes Say. July.

Oliarus aridus? Ball. August and September, at night, taken at trap light; October, twilight and at night, taken by sweeping. (Det. by H. Osborn, who remarked: "Differs in size, but may be only a variation.")

Megamelus marginatus Van D. July, at night, taken at trap light. (Det. by H. Osborn.)

Stobæra tricarinata Say. July.

Liburnia campestris Van D. July, in cornfield, a long-winged male. (Det. by H. Osborn.)

humilis Van D. July, at night, taken at trap light. (Det. by E. P. Van Duzee.)

ornata Stal. June and early July, in oats field.

osborni Van D. July to September, at night, taken at trap light. (Det. by H. Osborn.)

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21. A specimen name in U. S. Nat. Mus. Species to be described by J. R. de la Torre Bueno.

pellucida Fieb. July, in oats-stubble field; August, at night, taken at trap light. (Det. by H. Osborn.)
puella Van D. July, in cornfield. (Det. by H. Osborn.)
tuckeri Van D.[22] September. (Female type.)

Family CERCOPIDÆ.

Clastoptera xanthocephala Germ. May, July, in cage in oats field.
xanthocephala, glauca Ball. October, in the oats field.

Family JASSIDÆ.

Subfamily *Bythoscopinæ.*

Agallia bigeloviæ Bak. October, at night, by sweeping. (Det. by H. Osborn.)
sanguinolenta Prov. July, in alfalfa field.
uhleri Van D. August.

Subfamily *Tettigoninæ.*

Oncometopia lateralis Fab. July, in cornfield; August; October, in oats field.
undata Fab. July and August.
Diedrocephala reticulata Sign. July, at night, taken at trap light. (Det. by H. Osborn.)
versuta Say. July, taken while pairing.
Dræculacephala mollipes Say. May, at dusk, in oats field; June and July, at night, taken at trap light; July in corn and oats field; November.
Xerophlœa viridis Fab. June, in oats field, and at night, taken at trap light. (Det. by H. Osborn.)
Gypona cinerea Uhl. September, at night, taken at trap light. (Det. by H. Osborn.)
octolineata Say. August; August, at night, taken at trap light. (Det. by H. Osborn.)
pectoralis Spang. July to September, at night, taken at trap light; September.

Subfamily *Jassinæ.*

Xestocephalus pulicarius Van D. September, at night, taken at trap light. (Det. by H. Osborn.)
Spangbergiella vulnerata Uhl. September, at night, taken at trap light. (Det. by H. Osborn.)
Platymetopius frontalis Van D. July, in wheat-stubble field; October; October, twilight and at night, taken by sweeping.
Deltocephalus abbreviatus O. & B. July. (Det. by H. Osborn.)
inimicus Say. June, in cage in oats field; June and July, at night, taken at trap light; October, in oats field.
oculatus O. & B. August, at night, taken at trap light. One male. (Det. by H. Osborn.)
sonoræ Ball. June, in oats field; July, in wheat field; July and and August, at night, taken at trap light.

22. Bul. Buf. Soc. Nat. Scs., v. 10, June, 1912, p. 506.

Athysanus bicolor Van D. July, in wheat- and oats-stubble fields; August.
exitiosus Uhl. May, at dusk, in oats field; June, in oats field; July in cornfield and at random; July and September, at night, taken at trap light.
Eutettix strobi Fitch. July, in wheat-stubble and alfalfa field and at random; August, at night, taken at trap light.
subænea Van D., *var.* August, at night, taken at trap light. (Det. by H. Osborn.)
Phlepsius cinereus Van D. July. A male specimen.
decorus O. & B. August, at night, taken at trap light.
excultus Uhl. August, at night, taken at trap light.
irroratus Say. July, at night, taken at trap light.
Scaphoideus neglectus Osb.[23] September, at night, taken at trap light. (Cotype.)
Chlorotettix sp., near *unicolor* Fitch. July, at night, taken at trap light. A single female specimen.
viridius Van D. July; July, at night, taken at trap light. (Det. by H. Osborn.)
Tinobregmus pallidus Osb.[24] May; July, at night, taken at trap light; August; October, at night, taken by sweeping. (Cotypes.)
Cicadula nigrifrons Forb. May, at dusk, in oats field; June and July, in oats field; July, at night, taken at trap light.
sexnotata Fal. May, at dusk, in oats field; June and September, at night, taken at trap light.

Subfamily *Typhlocybinæ.*

Empoasca flavescens Fab. May; July, in cornfield; August; August, at night, taken at trap light. (Det. by H. Osborn.)
mali Le B. June and July, at night, taken at trap light; October. This species occurred more commonly than any other of the genus.
viridescens Walsh. June, at night, taken at trap light.
Dicraneura fieberi Löw. May, at dusk, in oats field. (Det. by H. Osborn.)

Suborder PHYTOPHTHIRES.

SUMMARY OF FAMILIES AND SPECIES.

Psyllidæ	4	Aphididæ	10

Families represented, 2; total number of forms, 14.

Family Psyllidæ.

Aphalara calthæ L. July, in cornfield. (Det. by D. L. Crawford.[25]
rumicis Mally. May; June, in cornfield. Det. by D. L. Crawford.[26]
First called *A. calthæ maculipennis* Löew by same authority.[27]
Heteropsylla texana Crawford. No data.[28]

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23. Ohio Nat., v. 11, Jan., 1911, p. 252.
24. Ohio Nat., v. 11, Jan., 1911, p. 261.
25. Pomona Jr. Ent., v. 3, May, 1911, pp. 495 and 496.
26. U. S. Nat. Mus., Bul. 85, p. 29.
27. Pomona Jr. Ent., v. 3, May, 1911, p. 496.
28. U. S. Nat. Mus., Bul. 85, p. 45.

Pachypsylla seltidis-mamma Riley. September; September, at night, taken at trap light; October, twilight; and November.

Family APHIDIDÆ.

Phylloxera devastatrix Perg. May, from galls on pecan tree, which was severely infested. (Det. by C. E. Sanborn.)

Pemphigus populitransversus Riley. November 3, in leaf galls of cottonwood (*Populus deltoides* Marsh.). (Det. by C. E. Sanborn.)

Toxoptera graminum Rond. May and June, apterous females in oats fields, disappearing shortly before harvest, but stock was bred in confinement on oats and wheat seedlings from first week of May to end of December.

Sipha n. sp., fide Sanborn. November 2, collected with *Siphocoryne avenæ* Fab., on wheat. (Mr. C. E. Sanborn has written about it as follows: "The new species of *Sipha* is one I have been pondering over for quite awhile. I first took this in Kansas in early spring. Its food habits are very peculiar, and in addition to wheat has oats and a few grasses like crabgrass. On some of them it has a subterranean habit. *S. maydis* of Passerini, pages 64 and 65 in 'Aphididæ Italicæ, 1863, is a closely related form, but is evidently distinct. The present form has nearly all the characteristics of *Siphocoryne avenæ* except in the antennæ. I have the illustrations and descriptions of it, which I think I will soon publish.")

Aphis maidis Fitch. June and July, extensively infesting corn. (Det. verified by C. E. Sanborn.)

setariæ Thos. May, on foliage of cultivated plum; September, on goose grass (*Eleusine indica*), hurrah grass (*Panicum texana*), finger grass, and two other kinds of grasses undetermined. (Det. by C. E. Sanborn.)

Siphocoryne avenæ Fab. May, apterous colonies on oats; June, winged forms in oats fields, occurring nearly to time of harvesting. First migrant in fall was found October 15, on oat plant in field; specimens found scatteringly in another field on the 23d, including one female with newly born young; still scarce in same field on the 31st; occurring rather commonly in wheat field on November 2; migrants and mature apterous forms, both with young, observed a few days later in other fields, wheat being apparently preferred to oats; winged and apterous forms found on the 24th, on oats seedlings experimentally grown remote from fields, but no specimens whatever in field inspected on the 25th; last example taken on experimentally grown oats seedlings, December 3. (Dets. by C. E. Sanborn.)

Rhopalosiphum serotinæ Oestl. May, dug from ground in cornfield near weedy corner. (Det. by C. E. Sanborn.)

Macrosiphum rudbeckiæ Fitch. August, on golden-rod (*Solidago canadensis*). (Det. by C. E. Sanborn.)

Myzus braggii Gil. May, on thistle (*Carduus sp.*). Det. by C. E. Sanborn.)

Order THYSANOPTERA.

Family THRIPIDÆ.

Limothrips avenæ Hinds. June and early July, in cages in oats fields; July, causing annoyance in house by entering through screens. (Det. by W. E. Hinds.)

Order CORRODENTIA.

Family PSOCIDÆ.

Cæcilius, prob. n. sp., fide Banks. October in corn field, November in experiment cage.

CLASS MYRIAPODA.

Although the following species is not a true insect, its addition to this list will not be out of place:

Order CHILOPODA.

Family SCUTIGERIDÆ.

Cermatia forceps Raf. During season, common in house.

THE HIGH COST OF FOOD.

Leon A. Congdon.

OF great importance to the people of this country is the high cost of food. It is common knowledge that the retail price which we pay for fuel energy and bodily growth is steadily advancing. This has not come about in the last year or two, as so many would have us believe, basing their claims on retail prices for the past four years. It is true that the fifteen principal articles of food alone have increased one-seventh in the last four years. The fifteen foods to which reference is made are sirloin steak, round steak, rib roast, pork chops, smoked bacon, smoked ham, lard, eggs, butter, milk, wheat flour, corn meal, Irish potatoes, and sugar.

It has been estimated that, starting with 100 as the basis for 1912, the percentage for 1916 was 114, or an increase of 14 per-cent in the cost of these combined foodstuffs in the four years just passed. The figures for the various foods in question in 1916 were: Sirloin steak, 120; round steak, 128; rib roast, 115; pork chops, 121; smoked bacon, 119; smoked ham, 120; lard, 116; eggs, 113; butter, 109; milk, 103; wheat flour, 107; corn meal, 104; Irish potatoes, 98; and sugar, 138. It will be seen that the greatest increases have been in the meats and in sugar, while in the case of Irish potatoes there was a slight decrease in cost in the early part of 1916, and an enormous increase in the latter part of 1916.

To any one who has been studying the subject of the high cost of food, these figures do not tell the whole story. The more one gets into the subject the less he seems to know as to the real cause of these prices. The speaker has obtained from a large number of sources the retail price of the fifteen principal articles of food for the past twenty-seven years. The most reliable sources found were government statistics. From 1890 to 1896, inclusive, a period of the first seven years of these twenty-seven, the tendency of the retail food prices was to go down, as shown by the curve in the accompanying chart. In fact, retail prices of foodstuffs were lowest in 1896. Then a change took place, and for the twenty years prices of foodstuffs have had a tendency to increase, the year 1916 showing the high-water price mark of the principal foodstuffs.

In 1916, with flour selling at prices higher than at any time since the Civil War; with potatoes far beyond the reach of the poorer classes, and meat prices being paid producers of meat animals showing almost 24 percent over what was paid for 1915; with butter, eggs and cheese all selling at higher prices than they were in 1915; beans with an increase of more than 70 percent over 1915; and onions more than 50 percent higher and cabbages more than 40 percent advance, we find the people alarmed, especially the masses who earn a small wage. Why was not something done fifteen years ago when prices began to advance above normal? You can see the advance in foodstuffs is not new, but a sudden jump in necessities called forth a challenge, and hence every department of the federal government is making an investigation which should have been made years ago.

Is it any wonder that most people are aroused at the present time? Staple foods such as butter, eggs and cheese have in 1916 advanced nearly 50 percent in price on the Chicago market, according to reports received in October, 1916, from dealers in provisions, and even greater increases are shown in the price of potatoes, cabbage and onions. Potatoes advanced from 48 cents a bushel to $1.45; cabbage sold for $3 a barrel as against 65 cents a year ago. Onions that sold in 1915 for 60 cents a sack brought $1.35. Flour increased more than 60 percent in 1916 over the year 1915 in October. Extras in creamery butter sold at from 38 to 40 cents a pound as against 27 cents a years ago for the same grade. Eggs retailed around 35 cents a dozen, the same classification selling a year ago at 23½ to 24 cents. Cheese dealers reported American cheese selling at 20 to 21½ cents a pound against 13¼ to 14½ cents a year ago. Other food products showed as much or more appreciation in value.

Food prices were comparatively abnormal and high in 1914 and 1915. Let us look at the crop production of 1914. The wheat crop of 1914 established in the United States record of 891,000,000 bushels, and was 128,000,000 bushels larger than any other year. The corn crop of 1914 was 2,673,000,000 bushels, and exceeded 1913 by 226,000,000 bushels. The potato crop for 1914 was 406,000,000 bushels, and was second in size in the history of the government and was 74,000,000 bushels larger than in 1913. The oat crop in 1914 was 1,141,000,000 bushels, and was third largest on record.

The domestic agricultural exports ending the fiscal year June 30, 1915 (the first year of the European War), were $1,470,000,000, an increase of 32 percent over those of the preceding year, or nearly 42 percent over the average of the five years 1910-1914. The exports during the first year of the European war, as regards food products, increased over the preceding year on such products as meats and dairy products from $146,000,000 to $220,000,000, wheat and wheat flour from $142,000,000 to $428,000,000, corn and corn meal from $7,000,000 to $39,000,000, oats from $1,000,000 to $57,000,000 and barley from $4,000,000 to $18,000,000.

The exports of wheat and wheat flour represented about 37 percent of the crop of 1914, the usual exportation being less than 20 percent. Farmers received an average of 79 cents a bushel for 1913 crop and $1.01 for that of 1914—an increase of 22 cents a bushel, or an aggregate gain of approximately $196,000,000.

There is said by some investigators of the high cost of food that there was a shortage of crops in this country during 1916, and that this is in part due to the high cost of food for that year. However that may be, government statistics given out recently show that the farmers of this country evidently boosted the prices. The value of corn raised in the United States in 1915 was $1,722,000,000; in 1916 it was $2,295,000,000. The value of 1915 wheat crop was $942,000,000; in 1916 it was $1,025,000,000. The 1915 oat crop was 559 millions; in 1916 it was $1,025,000,000. The 1915 barley crop was worth 118 millions of dollars; 1916 crop equalled 159 millions. The 1915 rye crop valued 45 millions; 1916 crop, 57 millions. The rice crop, 26 millions in 1915; in 1916, 37 millions. The 1915 potato crop was valued at 221 millions of dollars; 1916 crop, 417 millions. Sweet potatoes, 1915 crop, 46 millions; 1916 crop, 60 milions of dollars. Beans, valued at 26 millions in 1915, increased to 44 millions of dollars in 1916.

Let us take a review of the ten years from 1890 to 1899, inclusive. In these years we are not hampered by excessive domestic exports to war-ridden countries, nor do we have biased prices due to so-called investigators. The deductions are taken from the government statistics made before people clamored for an investigation. The average crop production for these ten years from 1890 to 1899 was in the case of wheat, for

example, 514,200,800 bushels in the United States. The average high price per bushel the following May in Chicago from 1890 to 1899 was 91.34 cents for wheat. The average domestic export from 1890 to 1899 was 173,044,583 bushels. In 1890, 1893, 1894, 1895 and 1896 both the production and domestic export were lower than the average for the ten years in question, but the highest price received per bushel above the average highest price at Chicago the following month of May was only found in the years 1890 and 1896. In the years of 1891, 1892, 1898 and 1899 we had simultaneously higher production and higher domestic export of wheat and flour than the average for this ten-year period, but the price per bushel paid in Chicago was lower than the average paid for this ten-year period. In 1897 we had higher production and higher domestic export of wheat and flour than the ten-year average; but contrary to what was expected, we had higher price per bushel paid at Chicago than the year average high price per bushel. In fact, the highest cash price paid for wheat in the Chicago market was in 1897, between the years of 1866 to 1914.

Probably the meat question is altogether the most important material problem with which the average family must deal in maintaining, for its every member, the fund of strength necessary to keep in the best working condition. There is probably no other problem of household economy or of individual maintenance that is so little understood by the average person as what makes the price of meat. We know the price of meat is high; in fact, so high as to be nearly prohibitive to the poorer classes. Even the packer of meat realized this when he said that a market condition that encourages the livestock grower to produce heavily and the consumer to eat generously spells volume of traffic, and volume of business at a small profit is a distinctive feature. He goes on to say that a market of this kind means a satisfied producer on the range, the farm, and the feedlot, and a contented consumer in city, town and country—everywhere.

The higher development of waste saving and the utilization of by-products in the packing plant depend upon volume. Perhaps the packer of meat is honest in his convictions, but he does not explain the millions of cattle, calves, sheep, lambs and hogs at the present time in hundreds of cold-storage plants. It is true that it takes two or three years to produce a steer and

almost a year to turn out a hog; but this is in the growing stage on the farm or range, and not necessary for the material to be kept in cold storage for that length of time. The spring of the year is a season of scarcity in the market in cattle, and sheep and hogs are scarce in the market in the autumn. Then meat takes another leap in the price. Markets in the packing business are busy in the fall when the ranges pour out their cattle and sheep and the winter brings the big run of hogs.

There is a difference in the prices of live cattle and dressed beef. The dressed-beef price is lower than the live-cattle price per pound because of the big profit in by-products and waste saving by the packer.

The real cause or causes of the high cost of foodstuffs has not been definitely determined. Some blame the housewife for her carelessness in buying and the inefficient and wasteful methods used in the home; others put the blame on the middleman's or commission man's profits; some go higher up the scale and point to trusts or monopolies; others say it is due to the storing of the food necessities in large quantities, either in cold-storage plants and warehouses or in the case of cereals in the terminal elevators or private elevators on the farm, there to await larger prices. There is, perhaps, no one particular cause, and there is no doubt that all these causes and others not mentioned contribute toward the high cost of the food supply. We must not forget that as civilization advances we have a higher standard of living. This together with the so-called "gambling" in the leading stock exchange markets of the country tend to inflate prices. Did you not notice recently how the price of wheat dropped on the market when it was thought that the European War was about to come to a termination?

There are many minor causes for increase in food cost. It is estimated that the delivery of goods adds 8 percent to the cost. The heavy export of foodstuffs to Europe and the alleged shortage of crops in this country tend to make temporary increase in food cost, but this does not explain the gradual increase of the cost of food for the past twenty-seven years.

In these times of high prices the consumer, except the more wealthy, must needs substitute cheaper foods for the more expensive. The housewife must be taught how to buy her food

for the home. It is likewise necessary that she be careful to utilize all wastes that she usually throws out. A large number of housewives throw out of the back door much useful material that can be made into nutritious and appetizing food material for the table. The occasional substitution of rice and corn for the more expensive wheat and potato, and the occasional substitution of fish and milk for the more expensive meat, will bring down the grocery bill and will not impair your health.

Food and Drug Laboratories,
State Board of Health, Topeka.

THE SCIENTIST ON THE FARM.

LYMAN C. WOOSTER.

IN TIMES PAST the scientist and the farmer have not been especially congenial companions. The scientist has found in the farmer too much to be corrected, and even censured, and the farmer has found in the scientist too much that seems to him to be visionary and uncertain to make these two, who ought to be the best of friends, seek each other's society. Farmers have been known to go miles out of their way to avoid passing a schoolhouse where a scientist had been advertised to lecture. One or two reasons for this incompatibility may well be mentioned here.

Farmers generally have been well trained in times past in the deductive methods of reasoning. The certainties of mathematics and the traditions of their forefathers were emphasized at home and in the public schools. The phases of the moon fixed the date of his sowing, planting and butchering; while drought, insect pests, and rust and smut were evils to be endured or exorcised by the priest.

The scientist, an expert in all forms of inductive reasoning, adds his own observations and experiments to those of a hundred other scientists, and thus reaches conclusions of far higher validity than those reached by a long chain of his ancestors through chance experiences. To be sure, new observations and experiments may lift his conclusions to higher and still higher planes of certainty, but these generalizations must always have far higher validity than the traditions of the fathers.

Of all people engaged in industrial pursuits the farmer is most in need of the power of prophecy, for he is surrounded by variables. The weather, his crops, his animals and his hired help are all in a condition of change, favorable to his interests or sometimes against them, and always requiring the powers of a scientist-seer to foretell the outcome.

THE SCIENTIST-FARMER.

When a scientist becomes farmer he at once takes up the task of elevating his conclusions to higher and still higher planes of validity. To do this he becomes in turn geologist, chemist, physicist, botanist and zoölogist.

As a geologist he studies the soils of his several fields and learns that the clay is derived from an underlying or near-by clay rock or shale (sometimes wrongly called soapstone), or has been brought from a far-away shale bed by some stream at flood from recent rains. Should our geologist-farmer live in northeastern Kansas instead of in Lyon county, he soon learns that a glacier shoved his soil from some near or far deposit to the north. He also learns that the clay of his soils may be the residuum of a bed of limestone. He remembers, furthermore, that he was taught when he studied geology that all the clay of eastern Kansas came originally from the feldspar of decaying granite in the Ozarks of Missouri or in the Arbuckle and Wichita mountains of Oklahoma, and that this is the reason that there is so much alkali in clay soils. (White alkali is chiefly sulphate of potash or soda, and black alkali is composed principally of carbonate of soda or potash.) In a similar way, sand is derived from sandstone, and this from the quartz of granite; but humus comes to the soil only through slow decay of plants and animals.

Then each in turn and all together the farmer-scientist brings to bear on the right solution of the many farm problems all the knowledge gained by the chemist, the physicist, the physiologist, the botanist and the zoölogist, and thus by myriad observations, experiments and conferences establishes conclusions of the highest validity, conclusions of far higher validity than those reached through tradition and casual observation.

Having stated his reasons for believing that the scientist-farmer is far better equipped with general principles of agriculture, gained by the inductive method of science, and why, when thus equipped, he can do with far greater certainty all classes of farm work, the writer desires next to give very briefly, for purposes of illustration, some of his own conclusions respecting farm soils and crops, assuming for the time being that he is a scientist and has been a farmer.

SOILS: QUALITIES AND USES.

1. Soil Body.—This is soil framework only.
   - *a. Clay:* Particles one five-thousandth to one two hundred fifty-thousandth of an inch in diameter. Clay is firm, slow and sticky.
   - *b. Silt:* Intermediate between clay and sand.

c. Sand: Particles one twenty-fifth to one five-hundredth of an inch in diameter. Sand is loose, quick and not sticky.
d. Gravel: Particles three inches to one twenty-fifth of an inch.
e. Stone: Three feet down to three inches in diameter.
f. Humus: A corrective of either clay or sand.
g. Water and air: Fill soil pores.
h. Remark: The loams consist of the various soil ingredients in different proportions, and are named accordingly. These are: clay loam, silt loam, sandy loam, gravelly loam, stony loam, and muck loam or humus loam. These terms are useful in soil surveys.

2. Soil Solutes.—Of direct value to crops in food making.
a. Carbonic acid: Source of carbon in food-making by green plants.
b. Water: Source of hydrogen and oxygen in food making by green plants.
c. The saltpeters and other nitrates: The only source of nitrogen for green plants in food-making.
d. Gypsum and other sulfates: The only source of sulfur for food-making by green plants.
e. Phosphate rock and other phosphates: The only source of phosphorus for green plants in food-making.

3. Soil Solutes.—Of indirect value to crops in food making.
a. Potash compound: Necessary to green plants in sugar production. How used is not known.
b. Humus: Used as food by nitrogen-fixing and other bacteria. Humus is essential to soil fertility.
c. Iron compound: A necessity in the manufacture of chlorophyll, though not a part of it.
d. Limestone: Neutralizes harmful organic acids.
e. Water: A universal solvent and a transporting agent.
f. Silica: Probably useful in protecting the stems of the grasses (the grains) against the attacks of sucking insects.
g. Common salt: Possibly useful in very small amounts, but in large amounts retards the endosmosis of water.

SOIL SURVEY MAPS.

Reports on the soils of Cherokee, Greenwood, Riley and Shawnee counties with large soil maps have been prepared by men from the United States Department of Agriculture in conjunction with men from our Agricultural College. Several other areas have been surveyed; but so far as the writer knows, reports on these areas have not been published. These surveys seem to have been carefully made, but the writer would like to make three suggestions which, if followed, would in his opinion make future survey reports more serviceable.

1. The writer would show the origin of the several soils by printing small geological maps of the several counties surveyed.

2. He would drop from the names of the several soils such meaningless terms as Oswego, Selby, Osage, Boone and Crawford. These terms cannot, from the nature of the case, apply to soils of several counties east or west.

3. The writer believes that the small maps of the Illinois soil surveys are more serviceable.

RESPIRATION.

It is now well understood by all physiologists that plants as well as animals need a constant renewal of the supply of oxygen in every living protoplasmic cell to release the energy locked up in the sugars, oils and proteins for the cell activities, or they die. But it is not so generally understood that the stem and root cells get their supply of oxygen from the soil; hence the need of thorough aëration of the soil through deep and frequent cultivation. The sandy loams and the silt loams are naturally more porous and better aërated than the clay loams; hence the need of more humus and more thorough cultivation of the last.

PLANT AND ANIMAL FOODS.

Foods are now defined as those substances which can be so changed by enzymes (usually from colloids to crystalloids, or from oils to soaps or emulsions) that they may be taken through the walls of living protoplasmic cells, and in the cells be used for the increase of protoplasm, or be oxidized for the release of energy. The starch and gluten of kernels of corn, wheat, rice, barley, etc., are as truly foods, under this definition, for the embryos of these seeds as they are for animals when they eat them. Much of the oil of most seeds is already in the embryos while these are in a resting condition, and may have been manufactured in the cell where found, but these oils still possess an essential quality of food—they may be oxidized for energy. The indefensible practice of calling certain mineral substances plant foods is being rapidly abandoned by scientists, and only lingers in textbooks of agriculture and in the advertisements of dealers in fertilizers.

AN UNSCIENTIFIC PRACTICE.

The major premises or the general principles of the mathematical and physical sciences, when established inductively by a genius in science, can thereafter be applied with great certainty by other minds to appropriate particulars in the field of arithmetic, algebra, geometry, physics and chemistry. No higher vision of truth results, but there is much satisfaction in the rediscovery of old truth and in the finding of new applications. In the mathematical sciences, textbooks from one to twenty centuries old are nearly as serviceable as when written. The form of the content only has changed. In physics and chemistry men of genius are still at work elevating some of the general principles.

The biological sciences, fortunately, can never come to rest. The life of plants and animals is a variable. The inherited race habits of species may persist for centuries with little change, but the conscious powers of the individual are constantly seeking new adjustments to their environment and thus modifying the race habits or instincts, otherwise evolution is an idle dream.

The biological sciences are young, and even the fixed tendencies of plants and animals cannot be formulated with certainty. Therefore the biologist must reason inductively to general principles that are mounting higher and higher, and thus having wider and wider application. Few textbooks on plants and animals are worth much when ten years old.

No biologist who keeps up with his sciences can grow old and static. The springs of life must keep ever fresh in his soul. The same cannot be said of the effects of the deductive sciences.

The tendency to follow set forms without change is illustrated by some tables prepared by the chemist for the information of farmers, usually unskilled in interpreting the technical formulæ of that science. It will be noted in the above table on soils that all the solutes, of both direct and indirect value to green plants in the preparation of their foods, are mineral salts except three or four.

As plants have developed the instinct to get their food elements from such compounds, these salts are the soil fertilizers, and all tables giving these fertilizers should give them in the form of salts and not as oxids, the usual practice, or the amount of the food elements present may be given in grams and per-

cents. Many chemists believe that the second method, that of designating the fertilizer by its food element or elements, is to be preferred. The chemical analysis would then give the weight of each chemical element in the fertilizer that will be of use to plants. The current practice is illustrated in the following table given in a much-used book on agriculture. This table gives the tons of "essential plant food" per acre-foot of different types of soil:

Table of "Essential Plant Foods."

	Sandy soil, tons.	Clay soil, tons.	Loess soil, tons.	Humus soil, tons.
Potash (K_2O)	2.42	6.38	8.70	6.39
Lime (CaO)	1.70	12.34	116.40	37.86
Magnesia (MgO)	.96	9.12	73.84	8.68
Phosphoric acid P_2O_5	1.74	2.82	4.00	1.50
Sulphuric acid SO_3	1.10	1.50	1.80	1.48

This and other tables given by the author of this book are of high value when translated into modern scientific language. When so translated the tables will be true in fact and in science; now they are true in form to neither. Potash is caustic potash, and no one who knows its qualities would think of using it as a fertilizer, and still less would he class it as a plant food. In the form of a salt, such as potassium carbonate, it is a valuable accessory plant food. The same may be said of lime and magnesia. Phosphoric acid is H_3PO_4, not P_2O_5, and sulphuric acid is H_2SO_4, not SO_3. Both of these are destructive to plant tissue and are never used as fertilizers unless they are in combination with some base forming a salt. Furthermore, not any of the oxids listed in the above table is found as an ingredient of any soil, and therefore the table is false in fact as well as in chemistry, and in plant economy except to one versed in ancient science. It is true that, according to the modern theory of solutions, mineral salts are believed to be dissociated into cations and anions. Thus potassium sulphate is thought to be dissociated in a water solution into the metal potassium (cation) and the negative radical, sulphur tetroxid (anion). But neither of these ions has the composition given in the above table, and therefore the table is incorrect in all respects when considered in the light of modern science.

SUMMARY.

Most of the general principles (major premises) of mathematics and the physical sciences have been the property of the

human race for hundreds, and some of them for thousands, of years. They constitute the salted-down portion of human knowledge, and exhibit no life or power of growth.

The general principles (major premises) of the biological sciences are being constantly elevated to higher levels of truth through the efforts of thousands of observers and experimenters in inducting new truth.

The scientist on the farm bewilders and even disgusts the old-time farmer with his new methods of farming, but the better crops of the scientist and his greater profits in raising sheep, hogs, cattle and horses are slowly convincing the neighbor farmer that the inductive methods of the biological sciences are best. High-bred seed crops and high-pedigreed domestic animals are slowly displacing the scrub plants and animals of his ancestors. Drought loses its terrors when faced by irrigation ditches and drought-enduring seed plants. Traditions brought from a far different environment are being dispelled by the warming influence of scientific common sense.

State Normal School, Emporia.

HEREDITY AND EDUCATION.

Lyman C. Wooster.

SOME of the powers of the human mind are evidently inherited, some are developed through contact with the natural environment, and some are certainly strengthened through the agency of schools; but just what part is played by each of these agencies, and just how much the adult mind owes to each, is a question that must be answered before the worth of schools and school studies can be determined.

1. *Is life an entity with powers of its own?*

Man's first inheritance from his parents is a tiny sphere of protoplasm—a fertilized egg cell, one one-hundredth of an inch in diameter. This sphere contains what are commonly known as matter, energy, and life. The matter of protoplasm consists of carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus—six elements not at all uncommon in other forms of matter. The energy, as is well known, is obtained by oxidation of food material stored with the protoplasm in the tiny sphere. Life, the chief entity of this fertilized egg cell, is said by the vitalist to control the matter through the energy,

and is the bearer of the hereditary qualities which are to characterize the future individual.

Many physical scientists question the presence of three entities in the fertilized egg, and some go so far as to say that there is but one. The reasons given are interesting and should be briefly considered here.

Chemists and physicists teach that matter consists ultimately of atoms. The smallest sphere visible under the best compound microscope is one one-hundred-thousandth of an inch in diameter. It would require four hundred hydrogen atoms placed side by side to reach that distance. The physicists say that the atom is made up of electrons and alpha particles. Six million electrons, side by side, would extend the length of the diameter of the hydrogen atom, and fourteen alpha particles would lie on the diameter of the electron. If an atom of silver were magnified to the size of an ordinary recitation room there would be a tiny sphere in the center of the room one twenty-fifth of an inch in diameter, consisting of one hundred alpha particles and fifty electrons, and fifty other electrons circling about the room. Thus the atom is mostly betweenness. Moreover, the physicists declare that the alpha particles are units of positive electricity and the electrons units of negative electricity. But electricity is a form of energy; and matter, therefore, is but a manifestation of energy. This would reduce the number of entities in the fertilized egg to two, energy and life. Are these two one?

Starting with the atom again, we learn from the chemist and physicist that atoms unite to make molecules. They probably have a definite arrangement in the molecule, and are held together by a force known as chemism. As the molecule and its atoms are invisible under the most powerful microscope, the definite arrangement of the atoms in the molecule is merely inferred, but there are several good reasons for this inference. The combining powers and the affinities of the atom and the molecule would cause special arrangements of the several different kinds of atoms in the molecule, and then several substances like gum arabic, and cane sugar, and the cellulose and starch, have exactly the same numbers and kinds of atoms in each of these two sets of molecules. These substances have very different physical properties, hence the chemist infers that this difference is due in part to the arrangement of the

atoms in the molecule and in part to the kinds and numbers of atoms. In a similar way the molecules in crystals of various minerals are held to have a geometrical arrangement peculiar to each mineral. This geometrical form is never varied except in accordance with well-known laws, and the mineral can be recognized in all cases by the form of the crystal. The crystallographer has demonstrated that crystals grow by additions to their exterior surfaces, and naturally infers that the molecules are arranged in accordance with their fixed polarities or cohesive attractions. So far as scientists can tell, the arrangement of the molecules in crystals has nothing to do with the function to be served by such an arrangement. Indeed, one form of crystal is apparently as good as another so far as the matter of the crystal itself is concerned. Unlike energy and matter, life is a variable, and full of purpose. It, therefore, cannot be either matter or energy.

2. *Life manages matter through energy.*

Living protoplasm is a puzzle to the chemist and the physicist. They do not find in matter associated with life the certainty that exists in the mineral world. The chemist believes that there are several kinds of molecules in protoplasm, but he is not sure how many. He knows the kinds of atoms in the molecules, but he does not know the number of atoms of each kind. The living protoplasm of plant cells can manufacture sugar, starch and fats from water, carbon dioxide and sunshine, which is far more than the chemist can do. Many chemical changes, such as oxidation of sugar and fats at ordinary temperatures, are only possible to the chemist at much higher temperatures. The chemical changes wrought in digestion, assimilation, and in the preparation of a myriad organic compounds, including the proteins, are mostly far beyond the ability of the chemist to produce or induce.

In a protoplasmic cell the molecules and groups of molecules have no fixed arrangement so far as is known to the physicist, nor are the cells rigidly grouped in the tissues, nor have the tissues and organs the same arrangement in different plants and animals. Furthermore, there is ceaseless change in living protoplasm. As the work of the cell proceeds, molecules are changed in composition; matter no longer useful is excreted, and new matter is absorbed and built into the cell structure in accordance with the needs of the cell in doing its work.

Matter in protoplasm, while subject to the physical and chemical forces, is evidently ruled by a higher influence, which the vitalist terms life, and it is the varying needs of this entity which causes ceaseless change in the matter with which it is associated. Its methods of doing work are so radically different from the forces that build the crystal or that control matter in any form that it must be placed in a class far removed from that in which we place those forms of energy known as matter and electricity.

3. *What does life inherit?*

Life, while associated with what we conventionally term energy and matter, builds of the matter, through energy, tiny cells containing protoplasm in the form of nucleus, cytoplasm, and cell wall. These cells, while alive, can absorb nutriment and oxygen; make of the one more protoplasm, and use the other to release energy; excrete matter no longer useful; by an internal set of activities make an exact division of the nucleus into equal parts, and a more or less equal division of the cytoplasm and cell wall, resulting in two complete cells; receive sensations from the environment; change shape of cell; and do or not do many other things.

The human infant begins its existence as an individual the moment an active sperm cell fuses with a sluggish egg cell. Potentially, this nucleated spheroid of protoplasm, about one one-hundredth of an inch in diameter, is the future child; but the chemist could not find in its composition the slightest difference between this cell and that of a thousand other cells of both plants and animals. When the fusion of the sperm and egg cells is complete the conjugate receives nothing further from its parents, except food, oxygen, shelter, and possibly nerve suggestions from the mother, till it ends its parasitic life on the day of its birth and becomes an independent organism. In the meantime the fertilized egg cell has become many million specialized cells through subdivision and growth. It first divides and becomes two cells physically equal in all their parts, as revealed by the microscope. At this point no one could tell whether the future organism will be a plant or animal. But the next cell division decides the question, for the two cells so divide as to make a square, and not a straight line as they would have done had they belonged to the plant

kingdom. The four animal cells next so divide as to make a cube of eight cells and then these so divide as to make a sphæroid of sixteen cells, the morula stage of the embryologist.

It would not be germane to the purpose of this paper to describe in detail the successive stages of development of this little embryo. We must note, however, that the life of the embryo child must act in accordance with its inherited tendencies, and decide at the morula stage that it will not cease its development and become, perhaps, a pandorina; at the blastula stage, and become volvox; at the simple gastrula stage and be a hydra; at the bisymmetrical, three-layered gastrula stage and be a worm; at the still more complex gastrula stage, with body cavity, notocord and nerve cord, and be a fish, amphibian, reptile, or lower mammal; nor at the higher mammal stage and be an ape; but it elects to belong to the genus homo.

As the embryo child develops from the one-celled to the many-celled condition, the daughter cells take nourishment as they multiply, and the embryo child, in consequence, is many million times larger at birth than the original egg cell. The cells of the embryo become specialized in form and function as they increase in number, in accordance with inherited tendencies, those of like form and function clinging together to form tissues, and the tissues combining to produce organs of the child to be.

The list of organs acquired through heredity before birth is as long as that possessed by an adult, but the organs are smaller, and at birth nearly functionless, merely the muscles and those with vegetative functions being at all active. The babe before its birth has mouth and tongue, but no teeth and no sense of taste; it has nose and nostrils, but no sense of smell; it has eyes, but it cannot see, and ears, but it cannot hear; it has hands, but it cannot feel, and feet, but it cannot walk. The baby has a brain with a full complement of nerve cells, but it has never used them in thought, and the cells are small with few or no dendrites and axones. It has a good pair of lungs, a complete alimentary canal with associated glands, a heart with blood vessels, kidneys and various other organs—all prepared before birth with plans and specifications acquired by its ancestors, some of them millions of years before, and handed down the line from generation to generation.

The most wonderful thing in the development of the embryo from a single fertilized egg cell to a great organism possessing many millions of cells so arranged that they can do many kinds of work — that which separates living beings from lifeless minerals controlled by the physical forces—is the power possessed by life to vary its response to the condition imposed by thousands of environments so as to enable myriads of individuals to succeed in their struggles for existence. Life has succeeded or failed in its response by acting, not as chemical or a physical force, but by managing these forces as the engineer manages his engine, or as life controls its body of many parts through energy. From birth to school age the child rapidly perfects those powers it needs in its adjustment to its environment. It learns to use its organs of special sense, and the neurones of its brain, spinal cord, and other ganglia push out their axones and their complexes of dendrites as needed.

This is the time also when the boy and the girl imitate their elders in speech and conduct. They find this exercise of their growing powers so interesting that they quickly learn all forms of play known to their parents and neighbor children, and soon become expert in these forms of exercise.

When school age arrives and schools are not accessible, the children readily acquire the powers and information of parents and neighbors and become their worthy successors in all individual and social enterprises. Such men as Lincoln, for example, became great with practically no schooling. This properly raises the question as to the value of elementary schools to boys and girls. One case does not establish a principle, but it is suggestive of the direction in which the truth may lie. In pioneer days in Kansas the people of a certain district in Lyon county were unable to agree on the site for a schoolhouse. A group of about twenty children, after two years in school, were kept out of school for six years while their parents strove to agree on a site for the schoolhouse. At last an agreement was reached and the building erected. This group of boys and girls had not become school weary, but on the contrary, longed intensely for a chance to get an education. As a result of this longing, and in spite of the loss of six years of elementary school training, from this group of twenty came several district school teachers, one professor of English in a university, one professor of science in a normal school, one

doctor of divinity, one veterinarian, and one practicing physician and surgeon. Interest in this case is strengthened by the fact that no one of special note in the educational world has come from that district since. May it not be that natural abilities are too often deadened by much of the work of the public schools?

It has long been a matter of common observation that children inherit their mental as well as their physical characteristics from one or both parents. Poets and musicians are born and not made. The same may be said of mathematicians, authors and scientists.

Mechanical geniuses are without exception adepts at mathematical reasoning. That this power is inherited and not acquired by the individual is shown by the uniform testimony of those strong in mathematics and mechanics to the effect that the power to solve problems and to work with machinery runs in the family. Sporadic appearances of mathematical power in such prodigies as Tom Fuller, an illiterate African, or Jedediah Buxton, a stupid English boy, are unusual forms of heredity; but such mathematical prodigies as Zerah Colburn and the Bidders, father and son, and relatives, who were members of families noted in spots for great memory, mechanical ability and mathematical power, were well educated and are not uncommon examples of inheritance of mathematical strength.

The power to use language in a very effective way, in addition to the power to memorize the writings of others, characterizes some of the most noted American families for several generations. The Jonathan Edwards family, the Abbott family and the Beecher family readily come to mind as illustrations.

In biological science, and in its related geological science, few names occur to one, for the observational sciences are still too young to show the influence of heredity. The names, however, of Darwin, Dana and Agassiz have continued through two or three generations of remarkable achievements.

So many warriors and statesmen show the power of heredity in their history that one wonders where else they got their ability to win battles and build nations. Painters and sculptors come, almost without exception, from families and nations gifted in these lines of art. All the great musicians of Europe come from peasant stock, much of it Jewish in origin.

The inheritance of physical characteristics has long been a matter of common observation. Little use has ever been made of this knowledge of physical heredity except in cases where it may be tribal or racial. In one other field, however, the shape of the skull has been taken to furnish a clew not only to the line of parental inheritance but also to the character of the individual. Most people judge of the abilities of strangers by the shapes of their heads, as they are thought to show in a general way the shape of the brain within. This method of determining character, when carried beyond its scientific bounds, led to the temporary establishment of a pseudoscience known as phrenology. Quacks practiced it, and it soon fell into disrepute; but the writer of this paper wishes to testify that the elder Fowler gave him a character from the shape of his skull and face which was wonderfully true to life.

In more recent years the brain itself has been studied in a scientific way and the entire surface of the brain has been divided into areas having specific functions. Those areas which control the activities of muscles have been pretty definitely established, and so have likewise been located the areas of cells which organize the percepts of some of the special senses. There are, however, in each square inch about one million nerve cells, most of which are functional. At least two-thirds of the cells in man's brain (quoted from "Hall's Adolescence," part 1, page 109) have nothing to do with the organs of sense or with the muscles, but are concerned with reason, science, judgment, moral and esthetic feeling, etc. Many of the areas, therefore, have functions whose nature can, at the present state of our knowledge, be conjectured merely; and the same likewise may be true of many of the cells in the areas whose functions have been determined.

Man's nervous system is first a hollow tube made from a furrow invagination of the ectoderm of the embryo along the back. Secondly, there appear five successive enlargements of this tube near its front end. From the walls of these enlargements are developed the basic ganglia of the brain and the cranial nerves. From the front enlargement bud the hemispheres of the cerebrum. At birth the cerebral hemispheres are ready for use in meeting the diverse conditions of the child's environments. The hemispheres continue to increase in size and depth of convolutions till the age of forty or fifty. The brain cells in-

crease in size, at least those that are functional, about a thousand times; but the main bulk of the brain at all times consists of axones and dendrites—the telegraph wires; so this increase in size of the cells through use does not greatly increase the size of the brain, that of the adult weighing about three and one-half times as much as the brain of the child at birth.

The stages in the evolution of man's brain are likewise shown in the brains of his fellow vertebrates which were left behind in the race for greater efficiency. The nervous system of the lancelet is merely a tube. The brain of the fish, amphibian and reptile consists of the basic ganglia with a small cerebrum. In birds the cerebrum, for the first time among vertebrates, exceeds the other basic ganglia in volume. Among lower mammals the cerebrum so much exceeds the other basic ganglia in size that it covers the optic ganglia on the rear and the olfactory lobes in front. Furthermore the cerebrum of modern mammals far exceeds in size the same ganglion in mammals of the same size that lived two million years ago. In man the cerebrum reaches its culmination in size and covers all the basic ganglia, including the cerebellum.

No reason is known to the biologist for this increase in size and complexity of the brains of vertebrates from the lowest to the highest and through the periods of geologic time, except that they used their wits more and more in their struggles for existence, the brain culminating in size and complexity in man. As the chief growth in size of the cerebrum is in the front and rear portions, those parts whose functions are largely conjectural, it would seem to be entirely safe to assume that the thought centers, the wit centers, are located largely in these portions. But normal children possess all these centers at birth; they are merely undeveloped. The nerve cells must take nutriment, increase in size, and grow a more complex system of association fibers. The activities of the mind stimulate the growths of the brain, just as the activities of the body cause special developments of its organs.

It should not be assumed, however, that the growth of mind and brain are unlimited, for heredity says, in many cases, thus far and but little farther. Doctor Goddard of Vineland, N. J., found in his institution for the feebleminded that idiots stopped developing mentally at two or three years, in spite of best efforts of teachers; imbeciles at seven, and morons at

twelve or fifteen; and in a majority of cases he succeeded in establishing the fact that feeble-mindedness was a family inheritance that could be traced back in a number of instances for several generations; hence the limitations were an inheritance.

Morons and the average negro of full blood are short in their heredity; they lack the later acquisitions of the human race. George Oscar Ferguson, jr., of Columbia University, says, in *The Journal of Heredity* for April, 1917, p. 153, in comparing the negro and white races, that "there are no considerable group differences in sensation, in motor control, in native retentiveness. The differences to which evidence has pointed have been in such abilities as those included under the terms constructive imagination, the apprehension of meaning, reasoning power. These latter traits divide mankind into the able and the mediocre, the brilliant and the dull, and they determine the progress of civilization more directly than do the simple and fundamental powers which man has in common with the lower animals."

Even among supposedly normal children heredity imposes its limitations. A superintendent of a city of the first class in Kansas looked up the records of all the pupils who were about to enter the junior high school, and found that they must be arranged in five or six ranks of attainment if he gave them work best suited to their needs. He did not look up the records of the parents, but had he done so he would have found, undoubtedly, that the same differences existed among the families.

The only scientific inference that can be drawn from the myriad facts of heredity is that powers that man exercises are his mostly by inheritance. Since he exercises these powers through neurones, and since at birth he possesses one-half as many functional neurones as the boy of fifteen possesses, the five or six years of pre-school experience, when his mind, rapidly awakens in response to the stimuli of his environment —these five or six years, I repeat, must largely determine the character of the future man. What, then, is the province of schools in preparing boys and girls for lives of present and future usefulness?

4. *What is the province of schools?*

Schools may, perhaps, hasten the fruition of the inherited powers of mind and body, but they cannot increase materially

the upper limit of these natural powers. In spite of the utmost that schools can do, one generation stands but a trifle higher in its natural abilities than the preceding. Nothing is more certain in heredity than the claim that algebra and geometry, for example, are easily mastered because of inherited strength, and there is no conclusive proof of the assertion that these subjects increase this natural strength when mastered by the pupil. This exceedingly slow growth of all species of both plants and animals toward higher levels of efficiency, even though the species may pass through a myriad new experiences, is one of the chief arguments advanced against the doctrine of evolution. By cross-breeding and selection alone, the evolutionist answers, can desirable qualities be established and be made to dominate the herd, field or garden, within a century; otherwise millions of years would be required in acomplishing this desirable result through natural selection, development and heredity.

No educator of any prominence now believes in formal discipline. His practice may be a half century behind his knowledge of the truth, but he will no longer contend that discipline acquired in mastering one subject may be made to function in the mastery of a different subject. It is as though entirely different sets of brain cells are developed in the two lines of study, together with their own association fibers.

Schools are plainly of value, therefore, in supplementing heredity, in giving skill in the use of the physical and mental powers, and in furnishing the mind with desirable information acquired and arranged in accordance with the scientific method. Ex-President Charles W. Eliot, in the *Atlantic* for March, 1917, quotes with approval the statement that the real objects of education — primary, secondary, or higher — are, first, cultivation of the powers of observation through the senses; secondly, training in recording correctly the accurate observations made, both on paper and in the retentive memory; and thirdly, training in reasoning justly from the premises thus secured and from cognate facts held in memory or found in print. To this admirable statement of the work of schools the author of this paper would merely add that the schools must teach children how to find wholesome recreation in play, how to enjoy the best in literature, and how to get real pleasure from the fine arts. The majority of people use their

leisure times badly, and the world will be a far happier place in which to live when people learn to get their pleasures with other people and not at the expense of other people.

Only those school subjects, therefore, are valuable which function in the after lives of the pupils, increasing their wisdom to its limits, giving skill in the use of their powers of mind and body, and adding valuable information and wholesome pleasures.

Such studies will be vocational, equipping for farm and garden, business, shop, or household; personal and environmental, teaching sanitation and personal hygiene and giving skill in observation and facility in the use of the inductive or scientific method of gathering information and of reasoning; informational, supplying those past and present experiences of the race which will guide future conduct; social, making such studies of man's relationship with man as will make him a better citizen and neighbor; professional, preparing for various special lines of activity; representative, endowing the pupil with power to express thought and feeling with the tongue, pen, pencil, brush or graver's tool, and giving him the ability to understand and enjoy the thoughts and feelings of others when thus expressed; and vibrational, attuning his mind and body to the highest and sweetest harmonies of pipe, string and reed.

If this paper has seemed to overemphasize the importance of heredity and to underestimate the value of schools, the writer has not so intended. While it is true that millions of species of plants and lower animals and certain races of man and many families of the more progressive races have become nearly static, and are therefore stay-behinds in evolution, it is also true that many other species and parts of species are not yet through changing their responses to an unfavorable environment or to an increasingly favorable environment, and are constantly modifying certain parts of their bodies through disuse or increased use. Man, according to Wiedershiem ("Structure of Man," pp. 200 to 205), is modifying the structure and function of about sixty parts of his body through changed response, and is causing nearly one hundred twenty other parts to become vestigial through disuse. The nerve cells of the brain with their axones and dendrites can but be modified in a similar way through use and disuse, especially in

the formative period of childhood and youth; hence the high value of the expert direction during this time.

Whenever the same response is continued through many generations the part of the body affected by this use or disuse becomes permanently modified in heredity. The pineal body in man's brain is believed by most anatomists to be the rudiment of a third eye. This unpaired eye is still functional in certain reptiles. Mammals of two million years ago had brains far less well developed in the upper front and rear portions than the brains in mammals of the same size of body today. It should be noted that the organs of man's body originated so far back in the ancestral line and in such a simple way that they were but slight modifications of preëxisting parts. As the developing parts increased in size and efficiency through use their formation came to be more and more an unconscious function of the ego, and thus became an inheritance.

5. *But what are the proofs of the inheritance of the effects of use and disuse?*

In considering this question it must be remembered that the rate at which new modifications of parts and at which new additions or subtractions to powers pass into the domain of heredity is of necessity exceedingly slow. Persistence in use or disuse for many generations is necessary to make much change, consequently the long periods of geologic time must elapse before the modifications are very noticeable. Therefore, the geologist is the only scientist who is fitted to answer this question with assurance, and he says, after examining the fossil remains of thousands of fish, amphibians, reptiles, birds and mammals, that acquired parts are inherited and disused parts are slowly lost.

The brain cavity of mammals, for example, has increased in size several times during the Tertiary and Quaternary periods; this increase apparently keeping pace with the more and more strenuous struggles for existence, demanding the greater use of wit. Cope discovered that the primitive molar tooth of mammals was tritubercular, with simple, conical tubercles. Osborne says that nearly all kinds of mammals—hoofed quadrupeds, monkeys, carnivores, insectivores, rodents, marsupials—are found building up their grinding teeth on the basis

of this primitive tritubercular ancestral form. Indeed, there is not a part of a vertebrate's body, capable of fossilization, that does not show progressive specialization or reduction. Furthermore, the embryos of mammals, including man, in their development from the fertilized egg, repeat the stages of development of the embryos of their ancestors, from the protozoan ancestor to the present.

Progressive loss of parts is likewise shown in the skeletons of fossil vertebrates. The early Tertiary ancestor of the horse, *Eohippus,* had four toes on the front foot, and three toes on the hind foot with a rudiment of a fourth toe. Later the ancestor of the horse had but three good toes on each foot; now the horse has but one toe on each foot, with rudiments under the skin of the second and fourth toes. In all cases the modifications are inherited. The embryo of the modern horse has five toes, but four of them fail to develop.

The vitalist explains this progressive gain or loss of parts and functions by instancing the well-known fact of observation that every unusual response must be made consciously; after much repetition the act becomes habitual, and in time it is established as instinctive, and is then inherited. But it must be remembered that additional responses in the same direction keep the part growing or diminishing.

As the inherited parts and powers are ready to function very nearly in the order of their acquisition by the race, the educator needs to be a student of geology, embryology and biology as well as of pedagogy. Professor James says that most people do not realize half of their possibilities, because they do not exercise all their powers of high value even to a safe limit. This dictum has in it certainly a large measure of truth, but is it not also true that people would come more nearly to realizing their true worth if the schools had found appropriate exercise for their powers of value as they arise? Not only should the subjects studied in schools develop inherited tendencies of high value, but other tendencies of little or no worth should be allowed to become vestigial through the dropping of those school subjects which cultivate them. These latter may well include the purely formal studies of the cur-

riculum. Indeed, part of the lack in efficiency which Professor James describes may well be due to the presence in our courses of study of those subjects which seldom or never function in the after lives of the pupils. All educators are agreed that formal discipline does not count; only specific discipline is of value.

STATE NORMAL SCHOOL, EMPORIA.

REPORT OF THE COMMITTEE ON RESEARCH.

SUBJECTS UNDER WAY AND PROPOSED.

P. F. WALKER.

AGRICULTURE.

Work under way:

Experiments in dairy feeding.

Deficiencies of corn as an exclusive ration for young pigs.

A study of the factors which determine gluten quality in flour.

Chemical and nutritional study of alfalfa.

The effect of prolonged production of alfalfa upon soil fertility.

The effect of different soil treatments, under dry-land agriculture conditions, on the nitrogen and carbon content of the soil.

State soil survey, and analysis of soil samples from state fertility investigations.

A study of nutrients in forage crops grown under different conditions and harvested at different stages of maturity.

Agricultural Experiment Station, K. S. A. C.; C. O. Swanson, Director.

Fruit bud formation; soil treatment, training, value of spraying.

Potato experiments.

Vegetable trial garden experiments; the effect of pruning, staking and spraying of tomato vines, varietal tests. Also tests to determine the practicability of growing certain vegetables during hot months.

Horticultural Department, K. S. A. C.

Garden project work.

Farm management (students collecting data on social and business needs and conditions in rural communities).

By Florence Billig and C. R. Phipps, K. S. N. S.

The relation of certain physical constants, nitrogen, and acidity to soil type.

By J. C. Russell, McPherson College.

Work to be started in 1917:

A study of the loss of sulphur in cultivated Kansas soils.

Acidity in soils.

Methods for the determination of acidity in organic materials such as flour, silage, feeds, and forage crops.

A study of soil colloids in relation to their effects upon soil texture, as well as upon general problems of plant nutrition.

Agricultural Experiment Station, K. S. A. C.

New method for determination of the moisture equivalent of soils.

Crop yields under a rotation system and a system of fertilizers on the College farm. (Same to include a list of a six-year grain rotation and phosphorus fertilizer and manure.)

Relation of fifth normal nitric acid soluble phosphorus to soil productivity in case of some McPherson county soils.

J. C. Russell, McPherson College.

Farm labor incomes from dairying as compared with those from other farm enterprises in Lyon county, Kansas.

Mr. Phipps, Mr. Roske, students, K. S. A. C.

AGRONOMY.

Work under way:

Causes of winterkilling of grain crops.

The cause and prevention of yellow berry in wheat.

The relation of soil type and moisture content to winterkilling of crops growing on it.

Cause of sterile florets in wheat and other cereals.

Changes in vegetative cover under pasture conditions, and the relation to pasture management.

The effect of time of cutting on the composition, yield, feeding value and permanence of stand of alfalfa.

Factors in development of kafir heads.

Factors in cultivation of corn.

Effects of environment on the habits of growth of Kentucky blue grass.

Effect of time of cutting on the yield, composition and feeding value of sudan grass, sorghums, kafir and corn.

Relative yields, rate of growth, temperature of the soil, and root penetration of listed and surface planted corn.

Relation of seeding winter grains in furrows to winterkilling and yield.

Effect of corn, kafir, and milo on the following crop of small grain.

Relation of time and method of preparing ground on the development of plant food and the yield of wheat.

Effect of different kinds of mulches on the conservation of water and the development of nitrates in the soil.

Relation of cropping systems and fertilizers to the composition, yield and milling value of wheat, and the yield of corn, alfalfa, cowpeas, and kafir.

Relation of variety to composition and yield of wheat.

The relation of time of seeding to winterkilling, tillering, and infestation of Hessian fly and yield of wheat.

The variety factor in the infestation of wheat by Hessian fly.

Work to be begun in 1917:

The effect of time of cutting on the yield, composition, and feeding value of sweet clover.

The relation of sequence of cropping to the yield of wheat, corn, alfalfa, oats, barley, and sorghums.

Work which is desirable:

Relation of humidity of air to temperature and the water requirements of various grain crops.

Further investigations along lines given above.

The above work is all under the direction of the Agronomy Department, K. S. A. C.

BACTERIOLOGY.

Work now under way:

A study of silage fermentation.

Supervised by O. W. Hunter, K. S. A. C.

Poultry disease investigations.
Supervised by J. G. Jackley, K. S. A. C.

A study of the differences existing in the nitrifying flora of soils possessing high and low nitrifying powers.
Supervised by P. L. Gainey, K. S. A. C.

Bacteriological investigations of flour.
Supervised by Miss Grace Glasgow, K. S. A. C.

Bacteriological investigations of dressed and undressed poultry shipped by parcel post.
Supervised by Prof. L. D. Bushnell, K. S. A. C.

Research upon improvements in methods of water analysis and upon the bacterial flora of the state of Kansas, with special reference to water purification and pollution of water supplies.
State Water Laboratory; Prof. C. C. Young, Director.

Study of *Leptothrix bucalis.*

Action of certain bacteria on starch grains.
By Prof. F. H. Billings, University of Kansas.

Studies on some pleomorphic streptococci.

Comparative content of Eck-fistula dogs.

Effects of certain chemical substances on the memolytic reaction.

Effect of animo acids on the hemolytic reaction.

Effect of different alkaloids on bacterial metabolism.
By Prof. N. P. Sherwood, University of Kansas.

The presence of soil and secal strains of organisms of the colon-aërogenes group in the surface waters of Kansas during wet and dry seasons.
By Prof. Myrtle Greenfield and Wilbur N. Skroup, University of Kansas.

The variability of organisms of the colon-aërogenes group in unfavorable media.
By Prof. Myrtle Greenfield and J. B. McNaught, University of Kansas.

Normal dog hemolysins.

Bacterial flora of normal urine.

Bacterial flora of cistern water.

Bacterial examination of Hamburger steak.

Bacterial examination of baby foods.
By Hal Sherman, J. D. Milligan, R. R. Fulton, E. Lee Treece, Roy Rankin, under the direction of Prof. F. H. Billings, University of Kansas.

Longevity of organisms of the colon-aërogenes group in soil and water.
By Prof. C. C. Young and Myrtle Greenfield.

BOTANY.

Work under way:

Anatomical studies of Kansas xerophytes.

Investigation of trees and shrubs adapted to Kansas conditions.
By Prof. W. C. Stevens, University of Kansas.

Semipermeability of seed coats.

Measurement of surface forces in soils.
By Dr. C. A. Shull, University of Kansas.

Anatomical study of the apical region of the mature sporophyte of the Marattiaceæ.

Origin of the mucilage ducts of the Marattiaceæ.

Survey of Kansas algæ.

By Dr. Grace M. Charles, University of Kansas.

Investigations in plant pathology.

By Dr. A. J. Mix, University of Kansas.

Anatomical studies of Kansas xerophytes.

Students, under the direction of Prof. W. C. Stevens.

Problems in plant chemics and plant physics.

Students, under the direction of Prof. C. A. Shull.

Survey of the algæ of Kansas.

Students, under the direction of Prof. Grace M. Charles.

Problems in plant pathology.

Students, under the direction of Dr. A. J. Mix.

Botanical survey of Kansas.

Students, under the direction of Prof. C. M. Sterling.

Work to be begun in 1917:

Continuation of the above investigations at the University of Kansas.

Preparation of a guide to the wild flowers of Kansas.

By Grace R. Meeker, librarian, Ottawa, Kan.

Systematic classification of plants of Lyon county.

Work in plant pathology, locally, endeavoring to discover as far as possible what plant and animal parasites are affecting our plants, those of economic or other value first.

By Prof. F. U. G. Agrelius, K. S. N. S.

Work which is desirable:

A complete survey of present pathological conditions.

Prof. F. U. G. Agrelius, K. S. N. S.

Problems in plant physiology and pathology (greenhouse equipment lacking.)

Prof. W. C. Stevens, University of Kansas.

CHEMISTRY.

Work under way:

The salt industry in Kansas.

A search for potash in Kansas.

The recovery of zinc wastes of flotation.

A survey of the natural gases of the midcontinental field.

The new petroleums of Kansas.

Disposition of creamery wastes.

The coking and gas-making qualities of Kansas coals.

By the Division of State Chemical Research; Prof. W. A. Whitaker, Director, University of Kansas.

Overvoltage in liquid ammonia solutions.

Dielectric constant of liquid ammonia up to its critical point.

Inert gases in natural gas.

Rate of reaction between hydrocyanic acid and formaldehyde as influenced by hydrogen iron.

By instructors O. L. Maag, W. N. Latimer, C. W. Seibel, and Harold Lentz, under the direction of Prof. H. P. Cady, University of Kansas.

Investigations of gas, oil, coal, and cement plaster.
By Prof. H. C. Allen, University of Kansas.

Nature of liquid potentials and the measurement of the same.
By Prof. P. V. Faragher, University of Kansas.

Researches in the cultivation of medicinal plants in the United States.

Further investigations of the digestive and baking qualities of corn oil in connection with mixed flour, especially a mixture of the commercial corn-starch flour and a high protein flour.

The composition of artificial rubber.

Further investigation of the poisonous constituents of mescale buttons.
By Prof. L. E. Sayre, University of Kansas.

Investigation of the new preparation now made official in the new Pharmacopœia IX; a critical study of the same.
By Prof. F. J. Zuck, University of Kansas.

A study of the value of the American-grown Stramonium.
By Prof. L. D. Havenhill, University of Kansas.

A study of the new constitutents of ipecac with reference to their therapeutic value.
R. L. Ritter, student, under the direction of Prof. L. E. Sayre, University of Kansas.

Methods of food analysis with particular reference to starch determinations and fat determinations.
By Prof. W. S. Long, University of Kansas.

The reaction of the formamidines.
By Prof. F. B. Dains, University of Kansas.

On the constitution and synthesis of certain pyrazol derivatives.
By Prof. Rolla N. Harger, University of Kansas.

On the action of acyl chlorides on certain thioureas and thiazols,
By R. Q. Brewster, Instructor, University of Kansas.

Reactions in liquid ammonia.
By Instructor J. B. Whelan, University of Kansas.

On the preparation and reactions of the isothiohydantoins.

On the introduction of iodine into aromatic amines.

On the action of substituted amines on carbonyl diurethan.

The synthesis of certain halogen substituted azo dyes.
By Roy Irwin, W. M. Janney, H. W. Greider, C. H. Kidwell, Carl L. Johnson, and A. T. Beckley, under the direction of Prof. F. B. Dains, University of Kansas.

Nutritive properties of maize and kafir.
By Prof. A. G. Hogan, K. S. A. C.

Investigation of the form of nitrogen occurring in plants, and especially that nitrogen which cannot be utilized as a food by animals.
By Prof. P. J. Newman, K. S. A. C.

The vitamine content of maize.

The effect of autoclaving casein on its chemical composition and nutritive value.
By J. S. Hughes, K. S. A. C.

Investigation of the auto disgestion of flour and the influence of inorganic salts upon this action. This includes a study of whole-wheat flour, patent flour, low-grade flour and straight flour, as well as the different mill streams from several commercial mills of the state.

By E. L. Tague, K. S. A. C.

The possibility of fats other than butter fat being used in the manufacture of evaporated and condensed milks.

The analysis of diabetic and dietetic foods.

The analysis of canned beans (for poor material.)

Comparison of methods for the determination of fat in ice cream, evaporated milks, condensed and dried milks.

The analysis of soils; samples of soil and hay taken from near a smelter in Kansas for arsenic and lead.

The detection of poor materials in mixed flours.

Pectin from grape fruit.

By Prof. C. A. A. Utt, K. S. A. C.

Food poisoning resulting from eating canned salmon.

By Profs. L. E. Bushnell and C. A. A. Utt, K. S. A. C.

The chemistry of paint, stains and varnishes.

By Prof. J. A. Yates, M. T. N. S.

Preparation of novocain and ethylene chorhydrine.

By Prof. Geo. E. Miller, Cooper College.

ENGINEERING.

Work under way:

The disposal of sewage in Kansas municipalities.

The softening of municipal water supplies.

The removal of iron from municipal water supplies.

By the Bureau of Chemical Industrial Research; Prof. W. A. Whitaker, Director, University of Kansas.

The measurement of electrical energy, electricity meters, rates for electrical energy.

By Prof. G. C. Shadd and C. A. Johnson, University of Kansas.

Distribution system for electric power as now employed in Kansas, with a study of possibilities for future development.

By Prof. F. E. Johnson, University of Kansas.

Investigation of the electrostatic field of high-voltage porcelain insulators.

By Prof. E. E. Hartman, University of Kansas.

Carbon brush tests.

Corona voltmeter tests.

Distribution of the electrostatic field of porcelain insulators.

By advanced students, in charge of Prof. E. E. Hartman, University of Kansas.

Stresses in railroad track.

By Prof. C. C. Williams, University of Kansas.

Determination of means for measuring the definition of optical instruments, surveying instrument telescopes in particular.

By Prof. W. C. McNown, University of Kansas.

Investigation of pressure of sand on sides of bins.

By Prof. F. L. Brown, University of Kansas.

Storage for impounding reservoirs in Kansas.
By Prof. C. A. Haskins, University of Kansas.

Probability of excessive rains.
By Professors Haskins and Welker, University of Kansas.

Industrial survey of Kansas, with study of conditions favorable to development of manufacturers.
By Prof. P. F. Walker, University of Kansas.

Efficiencies of gear teeth.

Efficiency of autogenous welded joints.
By Prof. F. H. Sibley, University of Kansas.

Relation of CO_2 content of flue gases to steam boiler efficiency.
By Prof. A. H. Sluss, University of Kansas.

Power requirements in the cement industry.

Pressure volume relationship of commercial gases.
By Prof. J. D. Garver, University of Kansas.

Concentration and metallurgy of vanadium ores.

Mechanical separation of zinc sulphide from iron and iron sulphide.
By Prof. R. L. Grider, University of Kansas.

Tests on concrete with a view of determining the effects of freezing and thawing upon the strength with various mixtures of ingredients.
By Prof. L. E. Conrad, K. S. A. C.

Tests on lubricating oils.

Tests on internal combustion engines with low-grade fuels.

Tests on oil traction engines.

Investigations on insulating materials for refrigeration.

Investigations of various carburetors for automobile motors, particularly with the view of utilizing fuels heavier than gasoline.

Investigations on the effect of compression upon the rate of flame propagation and maximum pressure in the case of internal-combustion engines, and with various fuels.
By Prof. A. A. Potter and mechanical engineering associates, K. S. A. C.

Investigations of the relative durabilities of various kinds of insulating materials for electrical conductors.

Investigation on windmill electric-lighting plant.

A mathematical study of the electrolytic theory.

Investigations on the cost of cooking and heating by electricity and with various appliances now on the market.

Investigations on storage batteries.
By Prof. C. E. Reid and electrical engineering associates, K. S. A. C.

Investigation and survey of location and arrangement of farm homes, farm buildings and outbuildings.

Investigation and survey of water-supply problems for farm homes, stables and feed lots.

Investigation and survey of heating and plumbing problems and systems for farm houses, garages, greenhouses, etc.
By Prof. J. D. Walters, K. S. A. C.

Investigations on paints.
By Prof. H. H. King, K. S. A. C.

Devices for use on binders when cutting grain in wet fields.
By Prof. F. A. Wirt and R. E. Wiseman, K. S. A. C.

Use of straw spreaders.
By Malcolm Aye, under the direction of Prof. F. A. Wirt, K. S. A. C.

Foundry and machine shop problems with attention to Kansas materials. Hardness tests on cast iron.
By Prof. W. W. Carlson, K. S. A. C.

Work to be started in 1917:

Durability of Kansas pavements.

Survey of available concrete aggregates in Kansas.

Shrinkage of concrete in setting.

Laws of pressure in viscous materials.

Water discharge over horizontal circular weirs.

Silt-carrying capacity of the Kansas river, and its relation to stage of the river.
By Departments of Civil Engineering and Mechanics, University of Kansas.

Power requirements in the metal-manufacturing industry.
By the Department of Mechanical Engineering, University of Kansas.

Investigations with steam engines and turbines, steam meters and Diesel oil engines.
By Department of Mechanical Engineering, K. S. A. C.

ENTOMOLOGY.

Work under way:

A study of the life history habits, and methods of control of the Hessian fly.
By Prof. Geo. A. Dean and J. W. McColloch, K. S. A. C.

Heat or high temperature as a means of controlling insects.
By Prof. Geo. A. Dean, K. S. A. C.

A study of the life history, habits and methods of control of the corn-ear worm.

A study of the life history, habits and efficiency of the chinch-bug egg parasite.

A study of the Thysanoptera of Kansas.
By J. W. McColloch, K. S. A. C.

A study of the life history, habits, and methods of control of the kafir ant and the maize bill-bug.

A study of the life history, habits and methods of control of subterranean insects, such as white grubs, wireworms, and false wireworms.
By J. W. McCulloch and W. P. Hayes, K. S. A. C.

A study of the Rhynchophora of Kansas.
By W. P. Hayes, K. S. A. C.

A study of the life history, habits and methods of control of fruit insects.

A study of the life history, habits and methods of control of termites.

A study of the life history, habits and methods of control of shade-tree insects.
By Prof. J. H. Merrill and A. E. Ford, K. S. A. C.

A study of the insects affecting alfalfa.

A study of the life histories of insects under controlled temperature and moisture conditions.

By Prof. M. C. Tanquary and R. R. Reppert, K. S. A. C.

Morphological, embryological and taxonomic studies on Enchytræidæ (Oligochæta).

Biological investigations on aquatic insects.

Experimental studies on certain free-living nematodes.

By Prof. Paul S. Welch, K. S. A. C.

Heat or high temperature as a means of controlling insects.

By Prof. Geo. A. Dean, K. S. A. C.

Relations between Toxoptera and Lysophlebus; a study of insect parasitism.

Relations of temperature to growth and development.

By Prof. S. J. Hunter, University of Kansas.

The limnology and ecology of Kansas Hemiptera.

By Prof. H. B. Hungerford, University of Kansas.

Physiological effects of insecticides.

By Prof. P. W. Claassen, University of Kansas.

Hibernation of orchard insects.

By W. H. Wellhouse, assistant state entomologist, University of Kansas.

A revision of the Coccidæ of Kansas.

By P. Lawson, instructor, University of Kansas.

The edipodinæ of Kansas.

By R. H. Beamer, assistant curator, University of Kansas.

Soil insects.

By B. P. Young, field assistant, University of Kansas.

The Gyrinidæ of Kansas.

By Forrest Anderson, student, University of Kansas.

The biology and economic value of *Paleacrita vernata.*

By Harry Fackler, student, University of Kansas.

Illustrative Processes for biological reproductions.

By Ellen Edmonson, student, University of Kansas.

Work to be begun in 1917:

Continuation of the biological survey of the Arthropoda of Kansas.

By the University of Kansas, Entomological Department.

Work which is desirable:

Relation of temperature to growth and development.

By the University of Kansas, Department of Entomology.

FORESTRY.

Work under way:

Developing of a practical method of controlling or preventing the damping off of coniferous seedlings in the nursery beds.

The developing of a practical method of treating red cedar seed to secure satisfactory and uniform germination in the nursery beds.

By Prof. C. A. Scott, K. S. A. C.

The effect of electric currents upon growing trees.

The effect of insecticides and other chemicals when introduced into the circulation by injection into the vascular system of the plant direct. (Experiments mostly confined to trees.)

By Prof. L. T. Reser, with aid of students, Baker University.

Work to be begun during 1917:

A study of the root development of fall-planted trees to determine the advantages of fall planting from this standpoint, if any exists.

Prof. Chas. A. Scott, K. S. A. C.

GEOLOGY.

Work under way:

The study of geology in its relation to the production of oil and gas.

By Alva J. Smith, Emporia.

Preparation of volume of geology of midcontinental oilfields.

Manuscript on general resumé of Kansas coal fields.

Manuscript on general resumé of Kansas gypsum beds.

Introduction to report on Cretaceous clays of Kansas.

Introduction to report on geology of good-roads material, clays, stone and cement.

By Prof. E. Haworth, University of Kansas.

Stratigraphy of the Kinderhook rocks of Missouri (to be published by Missouri Geological Survey.)

Lower Mississipian geology of Missouri and western Illinois.

Contributions to the paleontology of the Mississipian of the Central States.

By Dr. Raymond C. Moore, University of Kansas.

Contribution to the geology of Bermuda Islands.

Petrography of crystalline rocks of Kansas.

By Dr. Winhtrop P. Haynes, University of Kansas.

Glacial deposits of Kansas.

By Prof. J. E. Todd, University of Kansas.

MATHEMATICS.

Work under way:

Modern Geometry; a new line of material being developed into a text-book.

By Profs. John N. Van der Vries and E. B. Stouffer, University of Kansas.

Revision of textbook material in analytic geometry and calculus.

By Prof. C. H. Ashton, University of Kansas.

Notes on the n-dimensional cycles of an algebraic n-dimensional variety. (Published in *Rendiconti of Palermo*, Italy.)

Geometry on ruled surfaces. (Published in *American Journal of Mathematics.*)

The equation of Picaid-Fuchs for an algebraic surface with arbitrary singularities. (Published in *Bulletin of American Mathematical Society.*)

Cubic surfaces and their nodes. (Published in *University of Kansas Science Bulletin.*)

By Prof. S. Lefschetz, University of Kansas.

Solutions of linear nonhomogeneous partial differential equations.
By Professor Steinley, University of Kansas.

A study of comparative efficiency in algebraic construction.
By Prof. W. H. Garrett, Baker University.

Analytical geometry; material to be used for textbook purposes.
By Professors Andrews and White, K. S. A. C.

Preparation of material for an arithmatic adapted to the needs of the rural school.
By Professors Remick and Stratton.

PHYSICS.

Work under way:

Optical properties of metals.

Cold lights.
By Prof. George W. Tidd, head of the Physics Department, K. S. N. S.

Joule-Thomson porous-plug experiments on gases.
By Prof. F. E. Kester, University of Kansas.

Magnetic properties of crystals.
By Prof. T. T. Smith, University of Kansas.

Conditions affecting transmission of wireless signals.
By Instructor L. E. Whittemore, University of Kansas.

Possibility of wireless signals by use of atenna overtones.
By W. O. Lytel, graduate student, University of Kansas.

Work which is desirable:

Possibility of longitudinal ether vibrations in connection with certain light phenomena.
By Prof. George W. Tidd, K. S. N. S.

High-frequency currents.
By W. A. Van Vons, K. S. A. C.

PHYSIOLOGY.

Work under way:

The influence of the glands of internal secretion upon protein metabolism.
By Dr. S. A. Matthew, University of Kansas.

The influence of caffeine and diet on an athlete and nonathlete.

The influence of different kinds of music on cardiac activity and blood pressure.
By Dr. I. H. Hyde, University of Kansas.

The influence of the liver upon protein metabolism.
By Instructor Clarence Smith, University of Kansas.

The effect of oxygen on fatigue.

The efficiency of colored and white women compared during different intervals of time.
By students, under the direction of Dr. I. H. Hyde, University of Kansas.

Work to be started during 1917:

Sensory and motor regions of stimulation as recorded by the string galvanometer.
By Dr. I. H. Hyde, University of Kansas.

SOCIOLOGY AND ECONOMICS.

Work under way:

Social survey of Council Grove, Kan.

By Dr. M. C. Elmer, University of Kansas.

Collection of data concerning sanitary conditions of every city lot in Lawrence.

By Dr. M. C. Elmer, University of Kansas, and students in Department of Sociology.

The marketing of Kansas butter.

The fundamental principles of coöperation.

By Instructor T. Macklin, K. S. A. C.

Marketing of Kansas poultry and eggs.

By Ralph Van Zile, under the direction of Mr. Macklin, K. S. A. C.

Work which is desirable:

The organization and administration of rural credits.

By Prof. J. E. Kammeyer, K. S. A. C.

ZOÖLOGY.

Work under way:

The effect of the extirpation of the hypophysis as demonstrated in the frog, *Rana pipiens.*

The effects of the removal of the thyroid gland as illustrated in *Rana pipiens.*

Regeneration of germ cells in the hydroid, *Corymorpha,* upon the removal of the germ gland.

By Prof. B. M. Allen, University of Kansas.

Chromosomes of several species of crickets.

Methods of breeding in certain marine worms.

Life history of certain tunicates.

By Prof. W. J. Baumgartner, University of Kansas.

Chromosomes studies II: The problem of synapsis in the chromosomes of the Tettigidæ.

Chromosome studies IV: A case of a supernumerary deficient sex-chromosome.

Investigation of the inheritance of body characters correlated with germ-cell structures in the Tettigidæ.

A case of twins, one of which is a mule the other a horse.

The crossing of varieties of Peromyscus and Microtus.

The inheritance of skin pigment in Indian-white crosses.

Testing the inheritance of the effects of alcohol on guinea pigs.

Eugenic studies: Inheritance of human traits.

By Prof. W. R. B. Robertson, University of Kansas.

Endamoeba buccalis: Life history.

Light experiments on intestinal parasites.

By Prof. Nadine Nowlin, University of Kansas.

Structures and habits of *Diplocaulus.*

The position of the amphibia in our phylogenetic system.

The skull structure of Eryops, and a comparison of Texas and New Mexico specimens.

By Prof. Herman Douthitt, University of Kansas.

Life histories of parasitic flat worms.

By Earl O'Roke, assistant instructor in zoölogy, University of Kansas.

The effect of removal of thyroid gland upon the development of the other glands of internal secretion as typified in the frog.

By Jas. B. Rogers, student, working under Prof. B. M. Allen, University of Kansas.

The factors that determine the sex in the frog, *Rana pipiens.*

By Wilbur W. Swingle, Ph. D., thesis, under Prof. B. M. Allen, University of Kansas.

The effect of removal of the thyroid gland upon the development of the skeleton in *Rana pipiens.*

By George S. Terry, student, working under Prof. B. M. Allen, University of Kansas.

Spermatogenetsis of the domestic chicken.

By Lewis A. Curry, student, working under Prof. W. R. B. Robertson, University of Kansas.

Chromosomes of the turkey.

By Josephine Martin, student, working under Prof. W. R. B. Robertson, University of Kansas.

Halosporidium parasite of a marine crustacean.

By Regina Woodruff, student, working under Prof. Nadine Nowlin, University of Kansas.

Distribution of birds in Swope Park.

By A. E. Shirling, under Prof. W. J. Baumgartner, University of Kansas.

Sea slugs and other development.

By Ione Trees, student, under Prof. W. J. Baumgartner, University of Kansas.

Studies of inheritance and evolution in Orthoptera.

Studies of inheritance in skunks.

Studies of inheritance in karakule sheep and their crosses on American sheep.

Studies of inheritance in crosses of *Bos Indicus* on *Bos tarrus*, and the American bison on *Bos taurus.*

By Prof. Robert K. Nabours, Station Zoölogist, K. S. A. C.

Life histories of fowl cestodes.

Fowl nematode transmission.

Embryology of cestodes.

Dovainea cesticillus.

By Prof. J. E. Ackert, K. S. A. C.

Relation of cytology to heredity. (The structure of the germ cells in *Paratettix.*)

Gynandromorphism.

Superfetation.

By Prof. Mary T. Harman, K. S. A. C.

A study of the habits and distribution of the native mammals of Riley county.

An investigation of the factors determining habitat selection in the pocket mouse (*Perognathus paradoxus*).

Efficiency of various kinds of traps and methods of setting in the control of the pocket gopher (*Geomys bursaius*).

Efficiency of various kinds of poisons for use against home rats and pocket gophers.

By Lee R. Dice, K. S. A. C.

Work to be started in 1917:

Experimental work upon glands of internal secretion in larval frogs.

By Prof. B. M. Allen, University of Kansas.

Determination of effects of dissolved mineral substances upon the growth of normal tadpoles and of those which have been deprived of the hypophysis and of the thyroid glands.

By Prof. B. M. Allen and Prof F. W. Bruckmiller, University of Kansas.

Removal and transplantation of germ cells and germ glands in from larvæ.

By Prof. B. M. Allen, University of Kansas.

Testing the inheritance of the effects of lead poisoning in rats.

Studies of inheritance in varieties of prairie dogs, quail, prairie chicken and turkeys.

The role of the mitachondria in the germ cells of Fettigidæ, testing whether or not it is concerned in heredity.

By Prof. W. R. B. Robertson, University of Kansas.

The scapular foramen of lizards and other tetrapods.

Life history of anaplocephalidæ cestodes.

By Prof. Herman Douthitt, University of Kansas.

NECROLOGY.

LEWIS LINDSEY DYCHE.

Guy West Wilson.

THE subject of the present sketch, Prof. Lewis Lindsey Dyche, was born in Berkeley Springs, W. Va., March 20, 1857, of Scotch-Irish parentage. When he was three months old his father decided to remove to Kansas. The family came by boat to St. Joseph, Mo., and thence by ox team along the old Santa Fe trail to a point on the Wakarusa fifteen miles southwest of Topeka. Before their arrival at the new home the mother was taken very ill, and the babe was of necessity poorly attended. A band of Indians had their winter camp near the new home, and seeing the sad plight of the newcomers, took pity upon them. The women of the camp ministered to mother and babe, nursing the former back to health. Here the babe, the subject of this sketch, grew to young manhood. "With the precocity often seen in the pioneer life, he seemed to pass from infancy to manhood with no intervening period of boyishness or youth. All pleasures were combined with business. At the age of nine he was hunting and trapping along the Wakarusa. His playmates were his dogs; his playthings were the beasts and birds; his playgrounds were the woods and prairies and the camps of the Indians."[1] He was a lover of the open, an admirer of the wild life about him. In these early days he began to show the traits which were later to give him a place high in the ranks of American naturalists.

It is said that at the age of twelve he was unacquainted with the alphabet, and at sixteen was possessed of such scant learning that he was ashamed to show his ignorance in the village school. His educational progress was slow in the earlier years of his life, yet he attained an enviable eminence in later years. Finally he determined to secure an education. He had accumulated $600, with which he accordingly went to the State Normal School at Emporia, remaining for three

1. Edwords, Camp-fires of a Naturalist, p. 2

Bolman
L. L. Dyche

years. He then went with a friend to Lawrence, where he entered the University in the fall of 1877, enrolling in the middle preparatory class. His companion and himself both felt the need of strict economy. They came to Lawrence in a covered wagon, which they located in the ravine near the present site of the museum building. Here they lived until the frost of winter drove them to the more protected shelter of a rooming house. From the date of his entrance as a student to the day of his death, in Topeka, on January 20, 1915, Professor Dyche was intimately associated with the University. He began his college course with a study of the classics, but his love of nature led him to take up the sciences as then taught. He completed his course and was graduated in 1884 with both the degree of bachelor of arts and bachelor of science. He immediately entered upon his graduate work, and in 1886 was granted the degree of master of arts and in 1888 that of master of science.

While at the University he studied under Professor Snow, and came in touch with Professor Mudge, of Manhattan, during summer expeditions. Little wonder that with his natural bent and in such surroundings he should develop into a naturalist with broad interests and a deep insight into nature which gave him the vision of a seer. Professor Dyche is spoken of as a man of strong personality, of likable disposition, and with determination which carried him successfully through many serious difficulties. He stood high in the world of science. There are many stories related of him which reveal a kindly heart and an unselfish interest in his fellows.

Professor Dyche was married October 4, 1884, to Miss Ophelia Axtell, of Sterling, Kan. His wife and four children survive him.

We are especially interested with the scientific and professional career of the subject of our sketch. In 1882, before his graduation from the University, he was appointed instructor in natural history. In 1888 he was advanced to a full professorship, his title being professor of anatomy and physiology, and taxidermist and curator of mammals, birds and fishes. Two years later zoölogy was added to his list of subjects. After 1892 physiology and anatomy were removed from his jurisdiction, and his time given entirely to the field which he occupied until his death, except that during the academic

year 1899 he again taught anatomy. From now on the various changes in his title which appeared in the catalogue were merely matters of detail. At the close of his career his official title was professor of systematic zoölogy and curator of mammals, birds and fishes. He was a charter member of the Kansas chapter of Sigma Xi, fellow of the American Association for the Advancement of Science, and held membership in the American Ornithological Union, the Kansas Academy of Science, and the Biological Society of Washington.

The work of Professor Dyche covered a span of but little more than a generation in time, yet he left a monument which will endure as long as his University stands and learning attracts men. As a teacher his influence was felt by his students and associates. Coming to the University a poor country lad, he left as his monument one of the greatest collections of North American vertebrates, housed in the imposing building which bears his name. He was an explorer of no mean ability and accomplishment. In gathering materials for the University museum Professor Dyche, either on his own account or in company with others, made more than a score of expeditions. These led him into out-of-the-way places, where he faced privations and dangers, yet he saw only the results which he was achieving for his beloved University. He visited New Mexico, Colorado, the Cascades, British Columbia, northern Minnesota, Alaska, and finally the Arctic regions. He headed the expedition sent out in 1895 by the American Museum of Natural History, of New York City, to go in search of Peary, who was supposed to be lost in Greenland. He brought back rich spoils to the University, as well as rescuing the noted explorer.

In all the years which he devoted to the work of building up the University museum Professor Dyche showed a spirit of extreme devotion and self-sacrifice, his only object being to secure material for his institution. The specimens which he so generously brought to his alma mater would have commanded large sums of money had he been willing to sell them. So successful was he in his field of work that he had alluring offers to go elsewhere. To these he always turned a deaf ear, preferring to remain in his old haunts, even though it were at a great sacrifice.

On December 1, 1909, Professor Dyche was given partial leave of absence to accept the appointment of state fish and game warden. In making the appointment, the then governor, W. R. Stubbs, expressed the belief that he was bringing to this position the best qualified man in Kansas. That his judgment was well grounded was demonstrated by subsequent events. Professor Dyche had the training, the experience and the insight to make him especially well fitted to fill the position. Instead of merely accepting this as a matter of routine involving the issue of hunting licenses and the prosecution of offenders against the game laws of the state, he went to work with a will to make his department one of real benefit to Kansas. For several years previous to this appointment his work as a teacher had been limited to graduate students who were especially interested in his field of science or who wished to prepare themselves for museum work. From now on he did even less teaching, much of the time not even living in Lawrence. His influence in these years was probably greater upon the state at large, however, than it had been while a teacher.

When he assumed his duties as fish and game warden he found a most deplorable state of affairs. In his first biennial report he says that he had neither funds nor equipment; not even the reports of the fish and game wardens of other states. He fitted up a temporary laboratory in a buggy shed, equipping it with apparatus borrowed from the University, and for a working library he drew on his own library for some hundreds of volumes. He began in earnest the study of the problems of the fish and game resources of Kansas and their relation to the economy of the state. He had a vision, which he realized in part; and had his life not been cut short it would have been realized in a still larger measure. As it was he has left his indelible impression upon the state and nation for his work in the few short years which he was able to give to it. He began by seeking equipment not merely for the so-called practical work of his department, but for research work as well. The fish hatchery, with its magnificent equipment of laboratories and pools which he designed and constructed at Pratt, is a model for such institutions. Here he reared thousands of fish with which to stock the streams of Kansas. In this he saw a source of cheap and plentiful food. It was his wish that these laboratories might be made an adjunct to the University, and that the various departments which were

interested in aquatic life might be given the full advantages of this equipment for their research work. Such a scheme would have resulted in great benefit to the state, as it would have brought to the laboratory a corps of trained research men who would have contributed largely to the subjects in hand without involving additional expense to the state.

The influence and accomplishments of Professor Dyche are best measured, not by his published works, but by the influence of those institutions which owe their existence to his creative genius. While his list of papers is not a long one, and perhaps the bibliography here appended is not complete, some of them exerted a great influence with the people at large. Perhaps it is well to mention in this connection two of these which appeared in bulletins of the department of fish and game. The first of these was originally published as three separate papers, and then later grouped into one, under the title of "Ponds, Pond Fish, and Pond Fish Culture." In this he gave a scheme of fish culture which was especially adapted to the state of Kansas. This publication has had wide currency, both in the state and among pisciculturists of other states. Had he lived to continue the educational work which he so ably began, much would have been accomplished for the fish industry in Kansas, a state which would not naturally be expected to produce a great commercial bulk of such products.

Another line which he attempted to stress was the fur industry in Kansas. He published a bulletin on the fur-bearing animals of the state, in hopes that he might stimulate the development of a fur industry within her borders. He laid especial emphasis upon the value of the skunk as a fur bearer, designating it the most important fur animal living below the arctic regions. While he brought down upon himself the jibes of those wits who are always ready to poke fun at the accomplishments of others without danger of retaliation, he was successful in starting a fur-farming movement in Kansas. His second and last report contains quite a lengthy list of persons to whom licenses have been issued to conduct skunk farms, and mention of a few applicants for license to raise mink.

Last but not least, he secured the passage of a new code of game laws by the legislature of 1911. This code and the modifications which were passed by the legislature of 1913 presented his views upon the subject. It is among the best of its kind in the country.

Professor Dyche, then, by his unselfish devotion to his University and to his state, has left behind him a monument of his own erection which will secure for him a name, not only in the world of science, but also in the annals of those who have made that realm usually designated pure science a servant of man in the field of applied science in the best sense of that term.

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